4.0 FORMULATION AND EVALUATION OF ALTERNATIVES

4.1 Purpose of the Limited Reevaluation

The purpose of the MWD Project is to restore to the extent practicable the natural hydrologic conditions within ENP. The ENP segment of Shark River Slough, the deepest flow way inside ENP, requires higher average water stages and longer flooding durations (compared to current conditions) during the wet and dry season to restore and maintain slough habitat. Historic hydrologic conditions have been altered by the Tamiami Trail, the levees that enclose the southern side of WCA-3A and 3B, and L-29 Canal.

The Tamiami Trail feature of the MWD Project is needed primarily to:

1. create hydraulic conveyance capacity through the Tamiami Trail to allow a return to a more natural flow of water to ENP in timing, location and volume of delivery, as directed in the ENP Protection and Expansion Act 1989 and the 1992 GDM;
2. prevent loss of and restore ridge and slough vegetation through an increase in the volume of water delivered to NESRS.

The purposes of this LRR are:

1. to review previously proposed and new alternatives to identify a cost-effective plan that maximizes benefits in terms of hydrology (flow volume, timing and stages inside ENP), suitability for vegetation and potential ecological connectivity
2. to develop a recommended plan that can be implemented under the MWD authority and funding, and that provides a way forward and source of scientific data to guide the eventual provision of the greater flows and additional restoration anticipated in the future under the CERP or other authority.
3. to recommend a plan consistent with the policy constraints and guidance.

4.2 Problems, Opportunities, Objectives and Constraints

4.2.1 Problems

The fundamental problem identified in previous Tamiami Trail reports remains the same. The problem is a loss of much of the deepest, longest hydroperiod habitat inside ENP as a result of changes to the hydrology of the system. The Tamiami Trail roadway acts as a barrier to flow, reducing flows to the south, shortening the period of inundation (the hydroperiod), and substantially lowering the natural variability in the hydroperiod. Hydrologic changes began when the Tamiami Trail was built in 1929, but became worse after the WCAs were enclosed (circa 1962), further cutting off natural flow paths from WCA-3A to WCA-3B, concentrating southward flows west of NESRS, south of WCA-3A,

and cutting off flows from WCA-3B to the L-29 borrow canal and into the eastern Everglades area (refer to ***Figure 1-1*** and ***Figure 1-2***).

At the time that the WCAs were enclosed, the area east of S-333 was not part of ENP and was destined for agriculture. Therefore it was desired to route water away from this area. The 1989 Everglades Protection and Expansion Act changed the purpose of lands east of the S-333 and the L-67 Extension Levee from agriculture and private ownership to the NPS, and further directed the USACE to restore the eastern Everglades' hydrology to the extent practicable. The L-29 Levee, L-29 Canal and Tamiami Trail together create barriers that obstruct the free movement of water, aquatic organisms and wildlife between ENP and WCA-3B. ***Figure 4-1*** is an isometric figure showing that the L-29 Levee, L-29 Canal and Tamiami Trail act as a barrier to water flow to ENP south of the road. The vegetation depicted in ENP is ridge and slough landscape.

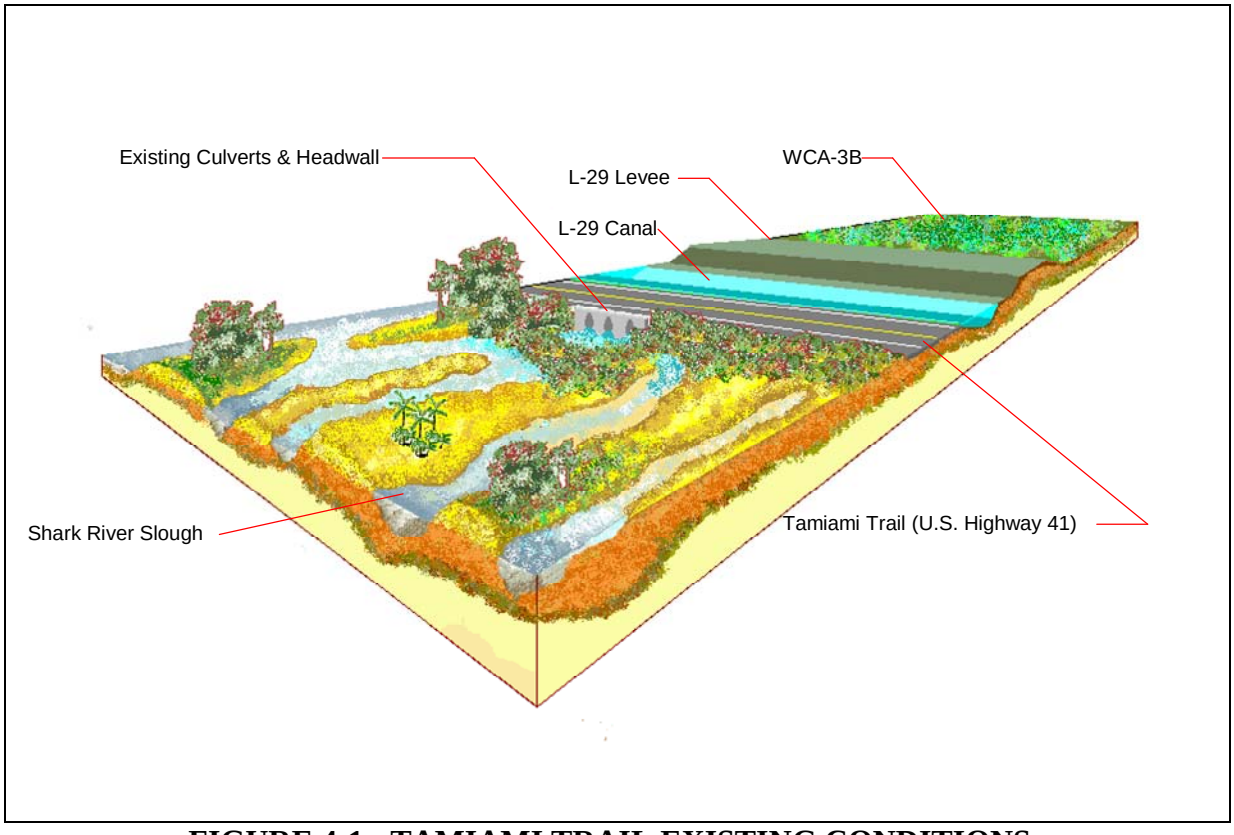

FIGURE 4-1: TAMIAMI TRAIL EXISTING CONDITIONS

Figure 4-2 and ***Figure 4-3*** allow a comparison of pre-drainage vegetation and recent, post-drainage vegetation in the area south of Tamiami Trail. These figures show the same red-outlined area where benefits and impacts were quantified. The J.H. Davis map of original, pre-drainage vegetation of the study area ***(Figure 4-2)*** shows the extent of the ridge and slough landscape. Davis recognized four dominant vegetation types in the potential impact area evaluated for improvements south of the Trail. They were, from approximately northwest to southeast: Deep sawgrass marsh (with tree islands shown as darker ovals and sloughs as lighter color), sparse sawgrass marsh, also with tree islands; medium to sparse sawgrass marsh (representing somewhat higher elevation, shorter hydroperiod and "marsh prairie", the shorter hydroperiod, shallower wetlands on the eastern slope up to more elevated lands to the east

Adverse impacts at the landscape level were caused by drainage and obstruction of natural flow pathways. A gradual loss of elevation difference between the tops of the ridges and slough bottoms created a flatter, more uniform topography, which led to conversion of plant cover to a more uniform sawgrass dominated community with fewer tree islands (***Figure 4-3***). In addition, major interruptions to ecological connectivity between the WCAs and the ENP, as well as animal mortality along the Tamiami Trail were results of the obstruction. It is certain that natural ENP systems would not recover their defining attributes under current conditions.

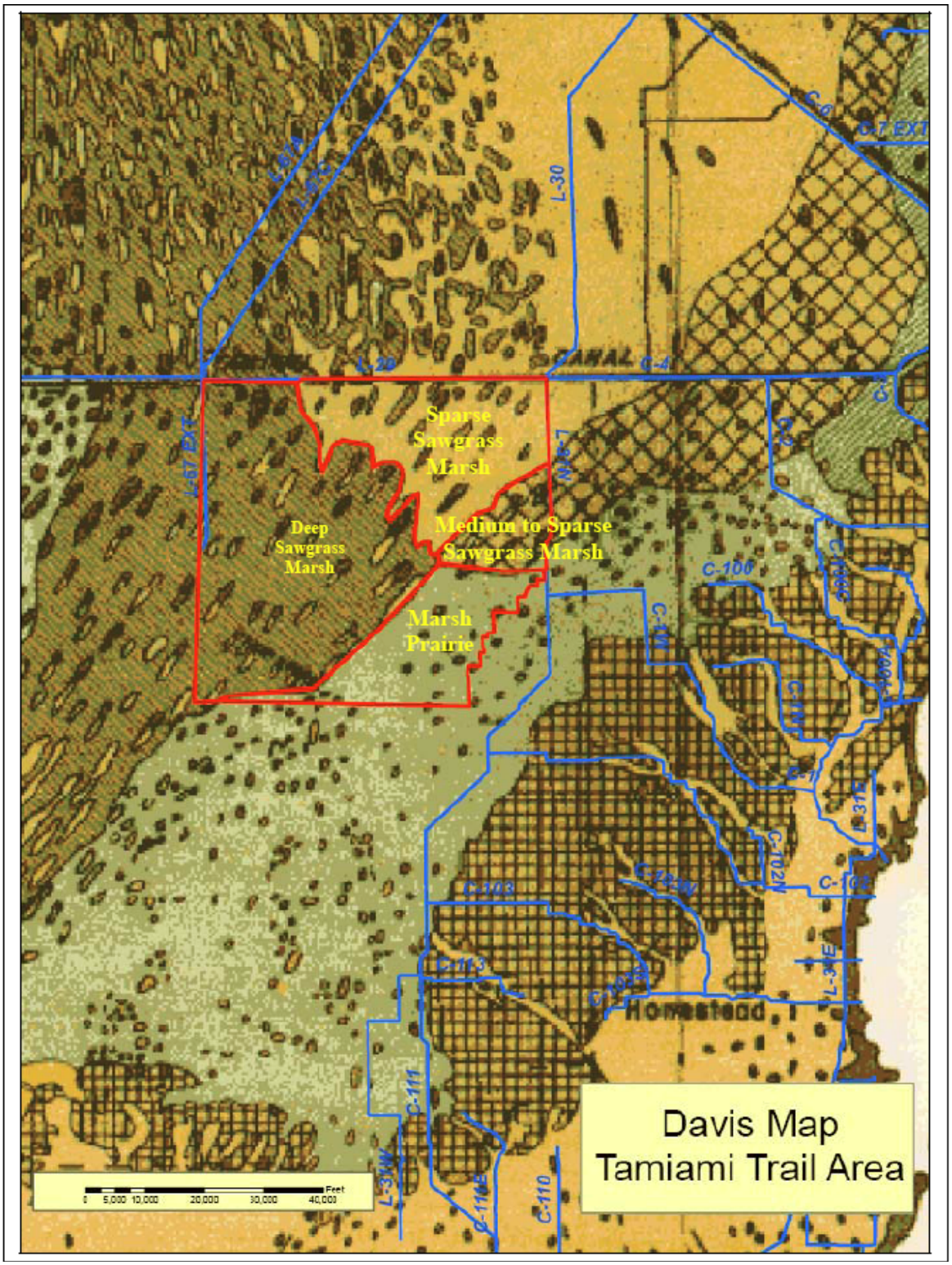

FIGURE 4-2: DAVIS MAP-ORIGINAL VEGETATION OF THE PROJECT AREA
(THE RED-OUTLINED AREA MATCHES THE RED OUTLINED AREA OF FIGURE 4-3)
(FOUR VEGETATION TYPES ARE LABELED WITHIN THE MAP)

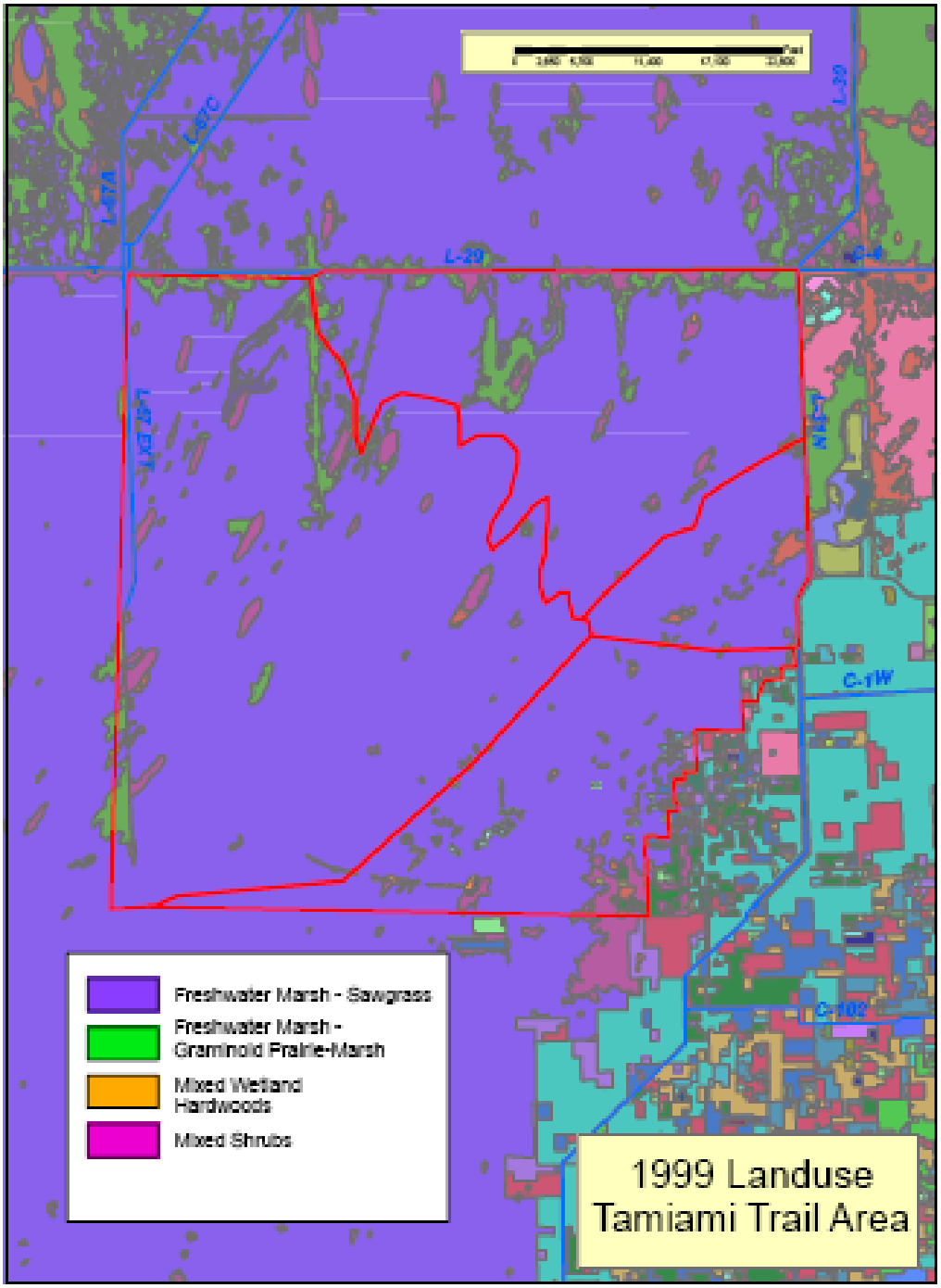

FIGURE 4-3: CURRENT LANDUSE CLASSIFICATION SHOWING SAWGRASS DOMINATION AND LIMITED TREE ISLANDS

(THE RED-OUTLINED AREA MATCHES THE RED OUTLINED AREA OF FIGURE 4-2).

4.2.2 Opportunities

The Tamiami Trail component of the MWD Project is part of an effort to restore the natural flows of water to ENP to the extent practicable. The Tamiami Trail project offers the opportunity for water conveyance to ENP with fewer obstructions to flows. This project includes opportunities to:

1. Allow delivery of more water into the eastern ENP and NESRS, restoring the balance of distribution between eastern and western deliveries, as proposed in the Mod Waters GDM, after the completion of the 8.5 SMA Project. The 8.5 SMA Project would remove a downstream flooding constraint.
2. Restore seasonal flooding and timing of deliveries that would enhance suitability for native vegetation and decrease the potential for invasive species colonization. At present most rainy season deliveries into the ENP are through the S-12 structures, located west of the L-67 Levee. Transfer of water delivery location to the east would benefit western sparrow populations while allowing late rainy season deliveries to continue for a longer season.
3. Increase the quantity of freshwater flows to NESRS. The added additional flows into the NESRS would increase the quality and quantity of ridge and slough habitat.

4.2.3 Planning Objectives

Based on a consideration of the purpose for the project, the problems occurring and the opportunities available to accomplish restoration goals, specific planning objectives for the LRR include the following:

1. Provide additional freshwater flows into NESRS, with more natural timing and distribution.
2. Restore processes that produce and maintain ridge and slough communities in ENP east of the L-67 Extension.
3. Restore slough vegetation and the deep water sloughs.
4. Reduce highway-caused mortality of animals moving across the Tamiami Trail.
5. Provide immediate peak flow capacity of 1,400 cfs with an ultimate target of 4,000 cfs.

4.2.4 Planning Constraints

The C&SF project and the construction of the Tamiami Trail have helped support the agricultural and urban development in and around the Everglades. This economic development has, however, adversely affected the ecosystem functions and values in the Everglades, including reductions in the spatial extent and functional quality of wetland habitat and decreases in native animal, fish and plant populations. While alternative plans are formulated to achieve

restoration of theses functions and values, to be considered for implementation, plans must also avoid violating planning constraints. The following constraints specifically affecting the project include:

1. Maintain at least one lane of traffic along the Tamiami Trail and avoid disruptions to traffic flows (e.g. residential and business access, hurricane evacuation).
2. Do not cause additional damages to the U.S. Highway 41 (Tamiami Trail) roadway.
3. Minimize adverse socioeconomic impacts on local businesses, residents and regional economies.
4. Avoid degradation of water quality in the ENP or any of the contributing water bodies within the basin.
5. Do not adversely affect listed threatened or endangered species.
6. Must start construction before 2010–later start would greatly delay implementation of major CERP components.

4.2.5 Future Without Project Conditions

The future without project conditions are the conditions expected in the project area if no project is implemented. It is a baseline for evaluation and comparison of alternatives. The study team assumed that future without project conditions would be similar to existing conditions. Section 3 of this report describes both the existing conditions and the future without project conditions. Please refer to Section 3 for further discussion. The future without project conditions for this planning study is synonymous with the No Action alternative under NEPA.

4.3 Alternatives

4.3.1 Plan Formulation Rationale and Overview

The plan formulation effort implemented within the LRR is designed to be a limited reformulation of alternatives identified during the 2005 RGRR and other viable alternatives that have been developed during the study process.

In order for additional water to cross Tamiami Trail, water elevation (stage) in the L-29 Canal must be raised and/or the openings in Tamiami Trail must be expanded. Alternative plans were developed as combinations of incrementally increasing stages and openings. The initial array of 26 action alternatives plus the No Action Alternative were tabulated beginning with the lowest stage increment, least action, in a progression to the highest stage increment plans, which were also those that produced the greatest benefits and most extensive structural changes.

After developing performance measure outputs and cost estimates for all 27 alternatives, the team screened alternatives based on whether the alternatives

met minimum performance levels for average annual flow volume, velocity differences, potential ecological connectivity, slough vegetation suitability, and by total project cost.

The screening resulted in a final array of four action alternatives plus the No Action Alternative. These plans were then reassessed and compared for ecological benefits, cost, cost-effectiveness, compatibility with CERP, and ability to implement. This second phase of evaluation identified the recommended plan.

4.3.2 Management Measures and Development of Alternative Plans

Management measures and subsequent alternative plans developed for this project were consistent with those that were produced during prior planning efforts. Management measures for this project focused on increasing conveyance of freshwater flows to ENP. In order to deliver additional flows, two major items need to be evaluated:

1. L-29 Canal Stage Increase: Increasing the stage in the L-29 Canal provides hydraulic head to push water from the L-29 Canal into Shark River Slough and to allow water to flow through the existing 55 culverts. Without a stage increase, there would not be the hydraulic pressure needed to push the water beneath the road. The greater the stage increase, the greater the water availability to ENP and the deeper the potential inundation and corresponding benefit to the ridge and slough community, depending upon operations and seasonal rainfall. The current stage constraint is 7.5 feet, which was introduced in part to prevent damage to the sub-base of the road. Therefore, it is a fundamental assumption that in order to raise the stage in the canal, the road would have to be mitigated to incorporate the change in water level (***Figure 4-4***). The stage in the L-29 Canal can be increased by increasing the amount of water allowed to flow through S-333 from WCA-3A into the L-29 Canal. S-333 is an existing structure that has operated for many years.

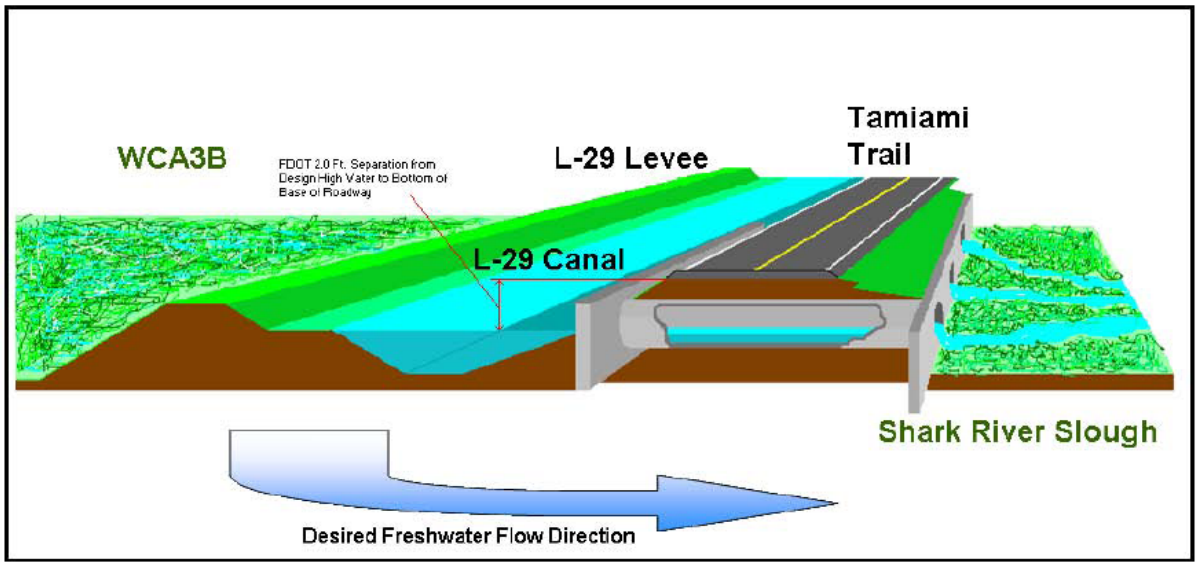

FIGURE 4-4: CROSS-SECTION OF TAMIAMI TRAIL WITH REINFORCED ROADWAY

2. Opening Size and Location: Increasing the width of the opening(s) beneath the Tamiami Trail would increase flow compared to the existing culverts. The major freshwater flow benefits of an increased opening span are derived from the reduction in head loss between the canal and marsh surfaces. By creating a larger space for water to flow between canal and slough, it creates a more equal distribution of water surfaces and functions to enhance the effectiveness of freshwater flows under any set of stage conditions. However, without a stage increase in the canal, there would not be the hydraulic pressure to push the water beneath the road; therefore, the stage must be modified to realize the benefit of the opening size. In addition to this hydrologic connectivity, larger openings provide for potential wildlife connectivity across the trail. The current long, rather narrow and dark culverts are somewhat like dark cave environments that may repel and inhibit passage of certain aquatic species, including fish, reptiles and amphibians adapted to bright surroundings. Even with the open deep water of the L-29 Canal located directly to the north of the northern culvert ends, it is expected that a more open passage illuminated indirectly, such as a bridge span, would enhance aquatic species migration. Wildlife passage is greatly limited under the current culvert openings, as the culverts are frequently wet and not suitable for migrating terrestrial species. Increasing the opening under Tamiami Trail would involve construction activity.

The team considered 0.5 foot increments of increasing stage constraints, starting from existing conditions (no increase) of 7.5 feet NGVD, then 8.0 feet, 8.5 feet, and finally 9.7 feet, which represents a return frequency of 20 years as predicted

by the Natural System Model (NSM). From a roadway design and frequency analysis using other future conditions (including CERP) a 9.7 foot stage was determined to provide reasonable protection to Tamiami Trail which allowed for unconstrained flow into ENP.

The team did not evaluate a 9.5 foot constraint as costs and benefits would be essentially the same as 9.7 feet. The team also did not evaluate a 9.0 foot constraint because at this stage the entire length of Tamiami Trail would have to be reconstructed, and the costs would approach those of a 9.7 foot stage while the benefits would be intermediate between an 8.5 foot constraint and an unconstrained stage of 9.7 foot.

Each incremental stage increase in the L-29 Canal required a consideration of impacts of the raised stage to Tamiami Trail. Increased water levels have the potential to damage the foundation of the road. The 8.0 foot stage constraint (0.5 foot stage increase) required reinforcing Tamiami Trail. The 8.5 foot stage constraint (1.0 foot stage increase) required more reinforcement of Tamiami Trail. At the 9.7 stage constraint, the road had to be reinforced sufficiently that the base of the road also had to be widened to support the increased height. ***Figure 4-5*** shows sample cross sections of the road changes that correspond to the increase in stage in the L-29 Canal.

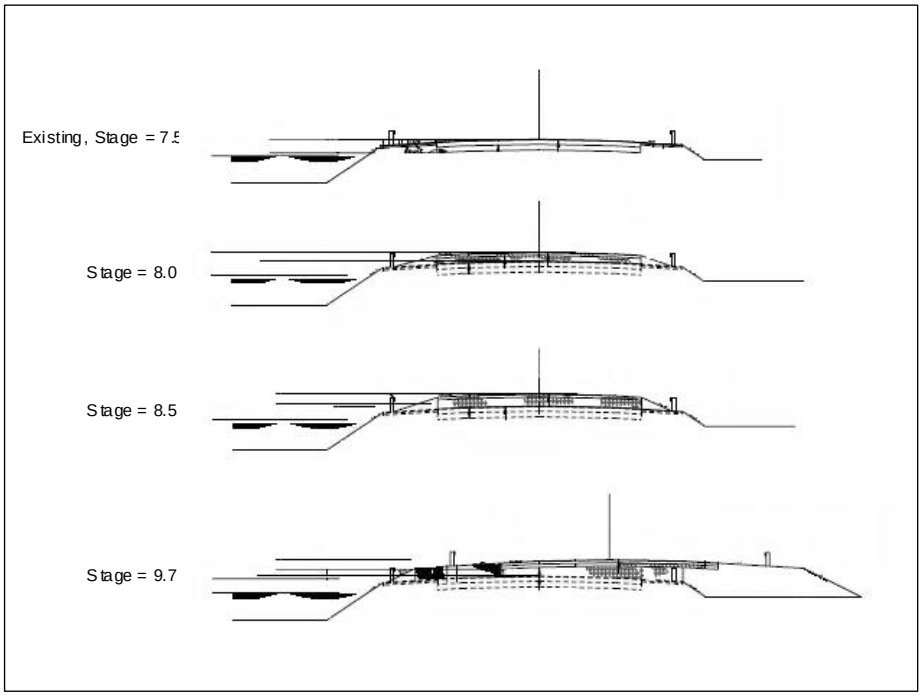

FIGURE 4-5: CANAL STAGE INCREMENTS AND ASSOCIATED MODIFICATION TO THE ROAD CROSS SECTIONS

When the team considered length of opening, many lengths between zero and 10.7 miles were initially considered. ***Figure 4-6*** shows the lengths and locations of the different openings in Tamiami Trail that were assessed in this LRR. Doubling the number of culverts and the 10.7-mile bridge were considered the minimum and maximum amounts of increase of opening size. It might have been possible to triple culvert density, but the estimated cost of doing so would have approached the cost of a one-mile bridge, while the total opening provided would have been only about 820 linear feet, while a one-mile bridge would provide 5,280 linear feet of conveyance.

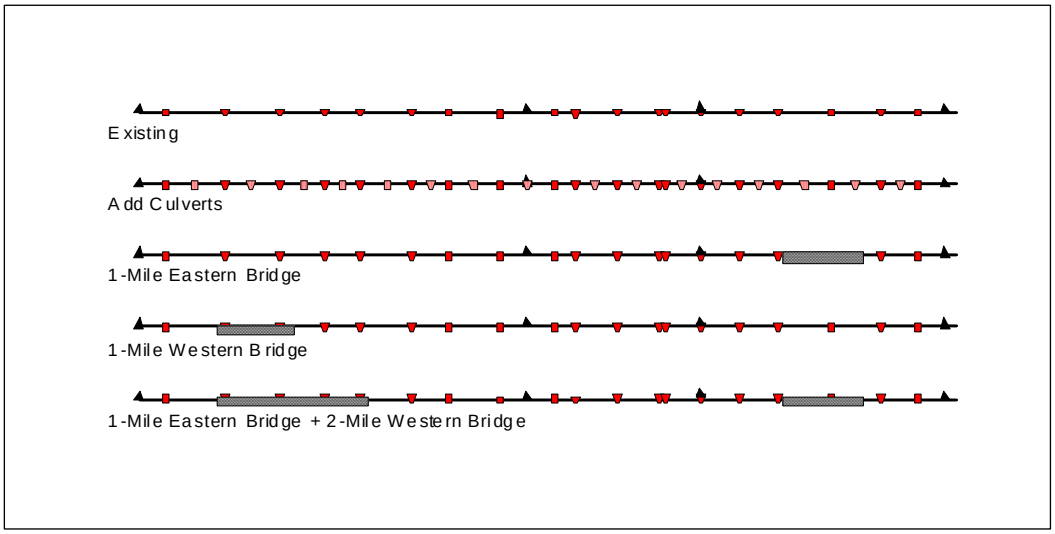

FIGURE 4-6: LOCATIONS OF THE OPENINGS ANALYZED IN THE TAMIAMI TRAIL ALTERNATIVES

(Existing, New Culverts, 1-Mile Eastern, 1-Mile Western, and 2-Mile Western Plus 1-Mile Eastern)
Note: The 10.7 mile-opening was also analyzed, but is not shown.

The two-mile west bridge plus one-mile east bridge opening (two bridges, three miles total) was selected for analysis because that alignment was part of the plan recommended in the 2005 RGRR. The 2005 RGRR Plan also included a stage of 9.7 feet. As this plan was subsequently determined to be too costly, thus initiating this reevaluation study, the LRR did not conduct detailed analysis of other plans with larger openings than the two-mile plus one-mile plan.

The team considered openings that were subsets of the plan selected in 2005. The eastern one-mile bridge would be the same location as the eastern one-mile bridge of the 2005 plan. The team considered a one-mile bridge that would be within the footprint of the two-mile bridge of the 2005 plan. The team did not pursue the two-mile western bridge from the 2005 plan because the cost

estimate developed during its design phase suggested that just this bridge was too expensive.

The team considered but did not pursue openings of less than one mile but larger than culverts. Analysis performed during the 2005 study demonstrated that there is significant head loss or difference of stage when the opening size is less than 5,000 feet (~one mile) (***Figure 4-7*** and ***Appendix D***). This differential is due to the interaction of the bridge opening size and the resistance of the downstream marsh to flow. This differential represents the additional height of water necessary to move water from the L-29 Canal into ENP. With openings smaller than one mile, much of the increase in stage of the various alternatives would be consumed by the head loss and little would be left to increase flows. Furthermore, a culverts-only alternative would not be compatible with future work under CERP. Any additional road reinforcement or bridging would require removal of most if not all of the work done under a culverts-only option.

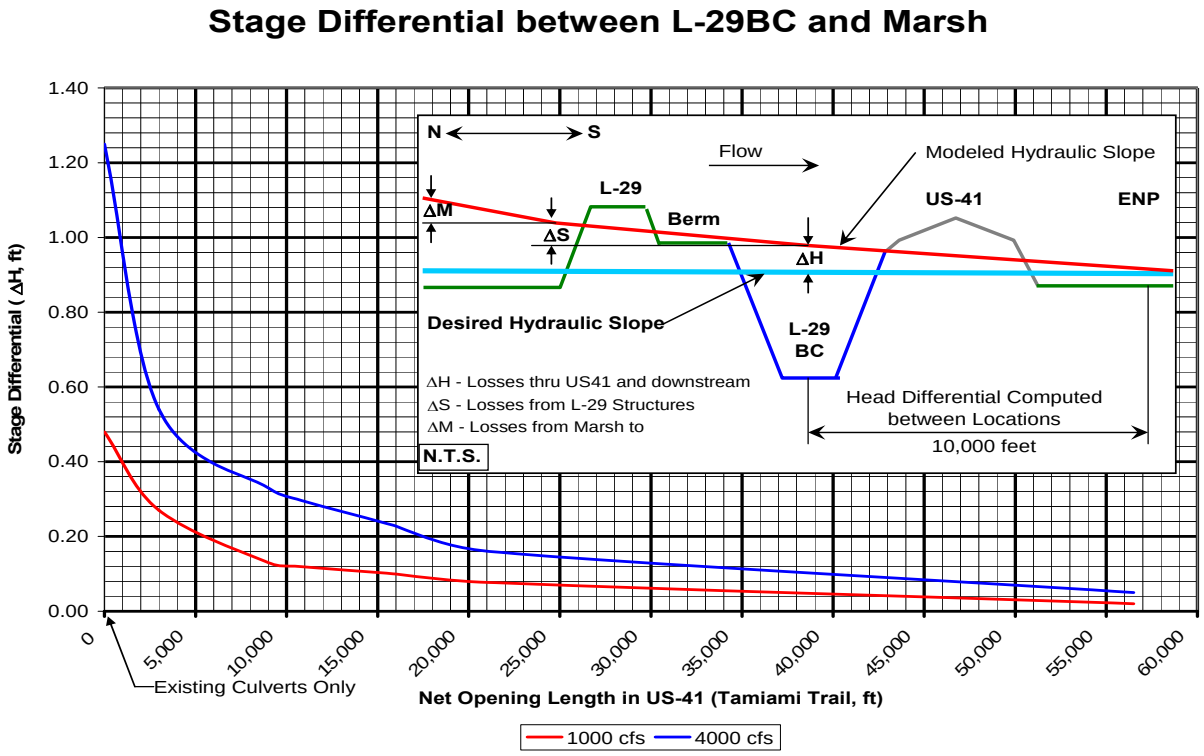

FIGURE 4-7: COMPUTED RMA-2 STAGE DIFFERENTIAL BETWEEN MARSH AND L-29 BORROW CANAL

These two variables, stage and opening, were used in various combinations to develop the incremental array of initial alternatives (***Table 4-1***) for the project. Operational changes to existing structures would be deferred to later studies and therefore were not considered in the formulation of alternative plans.

TABLE 4-1: TAMIAMI TRAIL INCREMENTAL VARIABLES AND MANAGEMENT MEASURES

CANAL STAGE (feet) and ROADWAY CROWN ELEVATION	OPENING SIZE/LOCATION
Canal Stage: 7.5 ft (Existing). Roadway Center Line El.: varies	19 culvert sets (existing), 38 culvert sets (19 existing, 19 new same location), 1 mile bridge (east), 1mile bridge (west)
Canal Stage: 8.0 ft Roadway Center Line Crown El.: 11.05 ft	19 culvert sets (existing), 38 culvert sets (19 existing, 19 new at same location), 1 mile bridge (east), 1mile bridge (west), 2 mile bridge (west) & 1 mile bridge (east)
Canal Stage: 8.5 ft Roadway Center Line Crown El.: 11.55 ft	19 culvert sets (existing), 38 culvert sets (19 existing, 19 new at same location), 1 mile bridge (east), 1mile bridge (west), 2 mile bridge (west) & 1 mile bridge (east)
Canal Stage: 9.7 ft (unconstrained flow) Roadway Center Line Crown El.: 12.75 ft	19 culvert sets (existing), 38 culvert sets (19 existing, 19 new at same location), 1 mile bridge (east), 1mile bridge (west), 2 mile bridge (west) & 1 mile bridge (east) 10.7 mile bridge (entire length of roadway)

Note: Existing roadway centerline varies from 10.1 to 12 feet.

Because of the cost to mitigate or compensate for impacts to the existing road, particularly for the higher canal stages that require that the road base be wider than the existing road, additional alternatives were evaluated that could be used to increase stage without the cost of road reinforcement. Structural alternatives include the use of levees to protect low portions. These alternatives include: (1) relocation of the road to another location, (2) construction of temporary levees to prevent road damage or (3) installation of pump stations. As previously stated, the initial array of alternatives focused on conveyance improvements based upon canal stages and opening sizes. A detailed description of each of the alternatives grouped by roadway center line crown elevations and canal stages is provided in the Engineering Appendix and ***Table 4-2*** below.

Some alternatives are identical to alternatives analyzed in previous reports. Alternative 4.2.3 of this LRR is the same as Alternative 14 of the 2005 RGRR Recommended Plan. Alternative 4.2.4, a 10.7-mile opening and bridge, is the same as Alternative 17 of the 2005 RGRR.

Alternatives do not all have the same number of conveyance openings. Three alternatives include two large openings with bridges. Thirteen alternatives include only one large opening with bridge. Four alternatives only add additional culverts. Seven alternatives do not include additional conveyance openings in Tamiami Trail.

4.3.3 Project Purpose

Recall throughout this report that the project purpose is to flow water from north to south. This project is not a transportation project. The management measures that are the components of almost all of these alternatives are: 1) increase stage in the L-29 Canal and 2) increase size of conveyance openings in Tamiami Trail, not building bridges and roads. The transportation features for the project are part of the compensation, known as the substitute facility, to FDOT for the acquisition of the needed real estate interests from FDOT. The descriptions and titles of the alternatives often refer to "bridge" and "road" because these would be the highly visible changes and these would be the high cost actions.

TABLE 4-2: REEVALUATION ALTERNATIVES

Alt	ALTERNATIVES	L-29 DESIGN STAGE (FEET)	DESCRIPTION
1	**No roadway reinforcement**		**There would be no increase in the elevation of the road except for Alternatives 1.4a and 1.4b, but this would be limited to minimal road reinforcement and only at the locations of bridges on roadway for pavement transitions. The L-29 Canal stage would remain at elevation 7.5 ft. NGVD.**
1.1	no action (19 culvert sets)	7.5	Requires no improvements to Tamiami Trail or its infrastructure.
1.2	spreader swales (30ft x 1000ft)	7.5	This alternative provides for spreader swales at each location of the 19 sets existing culverts. The swales have a bottom width of 30 feet wide and 1000 feet long.
1.3	add culvert sets (19 - 3x5ft dia) with swales	7.5	Add 19 sets of three 5 foot diameter culverts to the road. The new culvert sets would be installed adjacent to the location of the existing culverts. Spreader swales would be added at each location. This alternative would provide for a total opening size of 535 feet or 0.1 miles.
1.4a	add 1-mile eastern bridge	7.5	The 1 mile eastern bridge would be located between the Radio One communications tower and structure S-334. The bridge control water elevation (CWE) for this alternative is 8.75 ft. The bridge low cord would have to be 6 feet above the CWE elevation for inspection purposes. The low cord elevation would be 14.75 ft. NGVD.
1.4b	add 1-mile western bridge	7.5	The bridge would be located near the western end of the approximately 2 mile distance between Osceola Camp and Everglades Safari. The bridge control water elevation (CWE) for this alternative is 8.75 ft. The bridge low cord would have to be 6 feet above the CWE elevation for inspection purposes. The low cord elevation would be 14.75 ft. NGVD.
1.5	reinforce western section of road to 13.0 feet (crown) and add 1-mile western bridge	7.5	This is a subset of Alternative 5.4. It includes a bridge located near the western end of the approximately 2 mile distance between Osceola Camp and Everglades Safari. The remaining road between Osceola Camp and Everglades Safari would be elevated to minimum 13.0 NGVD at the crown. The remainder of Tamiami Trail would not be modified.
2	**Roadway improvements - Crown 11.05ft**		**These alternatives involve reinforcing the low areas of the road to a minimal roadway crown elevation of 11.05 ft. NGVD to allow stage increase in L-29 Canal stage to reach elevation 8.0 ft. NGVD. Road reinforcing would be allowed at bridge location for pavement transitions. Note: This would meet the current FDOT criteria established that the cross section crown elevation of the road be at least 3.05 feet above the average water elevation.**
2.1	reinforce low points along road	8.0	This alternative does not include any additional openings in the road.
2.2.1	reinforce low points, add culverts with swales	8.0	Add 19 sets of three 5 foot diameter culverts to the road. The new culvert sets would be installed adjacent to the location of the existing culverts. Spreader swales would be added at each location. This alternative would provide for a total opening size of 535 feet or 0.1 miles.
2.2.2a	reinforce road, add 1-mile eastern bridge	8.0	The 1 mile eastern bridge would be located between the Radio One communications tower and structure S-334. The bridge control water elevation (CWE) for this alternative is 8.75 ft. The bridge low cord would have to be 6 feet above the CWE elevation for inspection purposes. The low cord elevation would be 14.5 ft. NGVD.
2.2.2b	reinforce road, add 1-mile western bridge	8.0	The bridge would be located near the western end of the approximately 2 mile distance between Osceola Camp and Everglades Safari. The bridge control water elevation (CWE) for this alternative is 8.75 ft. The bridge low cord would have to be 6 feet above the CWE elevation for inspection purposes. The low cord elevation would be 14.75 ft. NGVD.
2.2.3	reinforce low points, add 2-mile + 1-mile bridges	8.0	The 2 mile western bridge would start approximately 0.5 miles east of the Osceola Camp and end near Everglades Safari. The 1 mile eastern bridge would be located between the Radio One communications tower and S-334. The bridge control water elevation (CWE) for this alternative is 8.75 ft. NGVD. The bridge low cord would have to be 6 feet above this elevation for inspection purposes. The low cord elevation would be 14.75 ft. NGVD.
3	**Roadway improvements - Crown 11.55ft**		**These alternatives involve reinforcing the low areas of the road to a minimal roadway crown elevation of 11.55 ft. NGVD to allow stage increase in L-29 Canal stage to reach elevation 8.5 ft. NGVD. Road reinforcement would be allowed at bridge location for pavement transitions. Note: This would meet the current FDOT criteria established that the cross section crown elevation of the road be at least 3.05 feet above the average water elevation.**
3.1	reinforce road	8.5	This alternative does not include any additional openings in the road.
3.2.1	reinforce road, add culverts with swales	8.5	Add 19 sets of three 5 foot diameter culverts to the road. The new culvert sets would be installed adjacent to the location of the existing culverts. Spreader swales would be added at each location. This alternative would provide for a total opening size of 535 feet or 0.1 miles.
3.2.2a	reinforce road, add 1-mile eastern bridge	8.5	The 1 mile eastern bridge would be located between the Radio One communications tower and structure S-334. The bridge control water elevation (CWE) for this alternative is 8.75 ft. The bridge low cord would have to be 6 feet above the CWE elevation for inspection purposes. The low cord elevation would be 14.75 ft. NGVD.
3.2.2b	reinforce road, add 1-mile western bridge	8.5	The bridge would be located near the western end of the approximately 2 mile distance between Osceola Camp and Everglades Safari. The bridge control water elevation (CWE) for this alternative is 8.75 ft. The bridge low cord would have to be 6 feet above the CWE elevation for inspection purposes. The low cord elevation would be 14.75 ft. NGVD.
3.2.3	reinforce road, add 2-mile + 1-mile bridges	8.5	The 2 mile western bridge would start approximately 0.5 miles east of the Osceola Camp and end near Everglades Safari. The 1 mile eastern bridge would be located between the Radio One communications tower and S-334. The bridge control water elevation (CWE) for this alternative is 8.75 ft. NGVD. The bridge low cord would have to be 6 feet above this elevation for inspection purposes. The low cord elevation would be 14.75 ft. NGVD.

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4	**Roadway improvements - Crown 12.75ft**		**These alternatives involve reinforcing the low areas of the road to a minimal roadway crown elevation of 12.75 ft. NGVD to allow stage increase in L-29 Canal stage to reach elevation 9.7 ft. NGVD. Road reinforcing would be allowed at bridge location for pavement transitions. Note: This would meet the current FDOT criteria established that the cross section crown elevation of the road be at least 3.05 feet above the average water elevation. Raising the L-29 elevation to 9.7 feet would meet the required elevation variations of the Natural System Model (NSM) as proposed in the CSOP or CERP.**
4.1	reinforce road	9.70	This alternative does not include any additional openings in the road.
4.2.1	reinforce road, add culverts with swales	9.70	Add 19 sets of three 5 foot diameter culverts to the road. The new culvert sets would be installed adjacent to the location of the existing culverts. Spreader swales would be added at each location. This alternative would provide for a total opening size of 535 feet or 0.1 miles.
4.2.2a	reinforce road, add 1-mile eastern bridge (RGRR)	9.70	The 1 mile eastern bridge would be located between the Radio One communications tower and structure S-334. The bridge control water elevation (CWE) for this alternative is 8.75 ft. The bridge low cord would have to be 6 feet above the CWE elevation for inspection purposes. The low cord elevation would be 14.75 ft. NGVD.
4.2.2b	reinforce road, add 1-mile western bridge (RGRR)	9.70	The bridge would be located near the western end of the approximately 2 mile distance between Osceola Camp and Everglades Safari. The bridge control water elevation (CWE) for this alternative is 8.75 ft. The bridge low cord would have to be 6 feet above the CWE elevation for inspection purposes. The low cord elevation would be 14.75 ft. NGVD.
4.2.3	reinforce road, add 2-mile + 1-mile bridges (RGRR)	9.70	The 2 mile western bridge would start approximately 0.5 miles east of the Osceola Camp and end near Everglades Safari. The 1 mile eastern bridge would be located between the Radio One communications tower and S-334. The bridge control water elevation (CWE) for this alternative is 8.75 ft. NGVD. The bridge low cord would have to be 6 feet above this elevation for inspection purposes. The low cord elevation would be 14.75 ft. NGVD
4.2.4	10.7-mile bridge (RGRR)	9.70	The bridge would extend the entire length of the project area, between S-333 at the western end to S-334 at the eastern end. The bridge control water elevation (CWE) for this alternative is 8.75 ft. NGVD. The bridge low cord would have to be 6 feet above this elevation for inspection purposes. The low cord elevation would be 14.75 ft. NGVD.
5	**Structural alternatives and/or road realignment**		**Many of the components of the alternatives of Category 5 have not been recently evaluated, such as placing bridge(s) on the L-29 levee rather than along the existing roadway and constructing new levees. These alternatives have received limited evaluation of alternative alignments and Rough Order of Magnitude estimates.**
5.1	northern alignment of Alt 14	9.70	This alternative locates the 2 mile/ 1mile bridge alternative to the north of the current location of the existing Tamiami Trail placing the roadway and bridges entirely onto the L-29 levee. The L-29 levee would be removed and three bridges would be constructed as part of the access curves to transition too and from the levee back onto Tamiami Trail. The top elevation of the road would be 12.75. The bottom cord elevation of the bridges would be 14.75. Water quality treatment of stormwater runoff is required
5.2	northern alignment with 1-mile bridge	9.70	This alternative is similar to alternative 5.1 except there is less bridging. A one mile bridge would be constructed on the west side of Tamiami Trail to the north of the current location of the existing Tamiami Trail, placing the roadway and bridges entirely onto the L-29 levee. The top elevation of the road would be 12.75. The bottom cord elevation of the bridges would be 14.75. Water quality treatment of stormwater runoff is required
5.3	northern alignment with 1-mile bridge and relocation of L-67 levee - Crown 13.00ft	9.70	This alternative would concentrate all increased water stages and all road work between S-334 and the Blue Shanty Canal / Everglades Safari. A 1 mile bridge would be constructed between Osceola Camp and Everglades Safari, aligned along the existing L-29 levee. There would need to be additional bridging to connect the new bridge to the existing road alignment. The L-29 levee would have to be degraded and compacted to make it a suitable sub-grade for the roadway. The road elevation itself would have to be a minimum of 13 feet NGVD at the crown. This alternative includes modifications to L-67A, L-67C, and L-29 levees and L-67A canal to promote water flow from WCA 3A into a small portion of WCA 3B and then under the reinforced portion of Tamiami Trail and into NESS. The proposed structural changes would include water conveyance features added in the L-67A levee, degrading a portion of the L-67C and L-29 levees, and plugging portions of the L-67A canal to promote sheetflow from WCA 3A, through WCA 3B and into NESS. The proposed modifications also include plugs in the L67A canal, with different degrees of backfilling, to investigate the changes in canal flow patterns, as well as, any adverse impacts to recreational boating/fishing. In addition, the plan includes the construction of a new boat ramp to maximize recreational access while the canal plug studies are being completed. Construction of temporary levees along the current north-south alignment of the Blue Shanty Canal in southwestern WCA 3B and northern NESS in Everglades National Park, and a new gated water control structure in the L-29 canal at the temporary levee alignment The Levee to the South and the Levee to the North would be constructed to elevation 13 NGVD. The levee would have 4 to 1 side slopes for maintenance until it is removed at a later date. The road would have to be reinforced to cross the levee which would put the crown at 15 NGVD over the levee.
5.4	current alignment with 1-mile bridge and relocation of L-67 levee - Crown 13.00ft	9.70	This alternative would concentrate all increased water stages and all road work between S-334 and the Blue Shanty Canal / Everglades Safari. A 1 mile bridge would be constructed between Osceola Camp and Everglades Safari, aligned along the existing road. The remainder of the road within this section would be reinforced to a minimum elevation of 13 feet NGVD at the crown. The road cross section would be similar to Alternative 4.2.3. The section of the L-29 levee opposite this new bridge would be removed. This alternative would include moving the L-67 extension eastward to the Blue Shanty canal edge. The Levee to the South and the Levee to the North would be constructed to elevation 13 NGVD. The road would have to be reinforced to cross the new levee which would put the crown at 15 NGVD over the levee.
5.5	pump stations along L-29	-	This alternative would use a pump to move water from the L-29 Canal into Northeast Shark Slough (NESRS) utilizing existing openings under Tamiami Trail.

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4.4 Initial Evaluation and Screening

All 27 alternatives were evaluated for hydrologic and ecosystem restoration benefits, project cost, real estate impacts, implementation schedule, and compatibility with the CERP. Based on this analysis, all action alternatives show an improvement in hydrologic performance compared to the No Action Alternative. As the stage and opening size increases, the performance also increases. A subset of the results of these evaluations is displayed summarized in an evaluation matrix (***Table 4-3***) to identify the top performing plans.

The next subsections of this report provide a summary of how the evaluation parameters were applied to the 27 alternatives and discuss constraints and minimum performance relative to the parameters that were considered. A more in-depth explanation of all of the evaluations can be found in the Hydrology and Hydraulics (D) and Benefits (E) Appendices. The comparison analysis and screening produced a final array of four alternatives, which were then further evaluated.

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TABLE 4-3: TAMIAMI TRAIL PLAN FORMULATION MATRIX

ALTERNATIVE			BENEFIT SUMMARY								COST INFORMATION		IMPLEMENTATION		
Alt	ALTERNATIVES (note 1)	L-29 DESIGN STAGE (FEET)	BENEFIT AREA (ACRES)	1 in 10 YEAR PEAK FLOW (cfs)	AVERAGE ANNUAL VOLUME (kacre-ft/year)	% VOLUME INCREASE	% CONNECTIVITY	VELOCITY DIFFERENCES, MARSH AND OPENING	NUMBER OF DAYS W/ DEPTHS > 2 FEET	AVG ANNUAL LIFT (HU)	AVG ANNUAL COST PER HU ($/HU)	TOTAL TTM COST ($M)	NEPA / Report Coverage	CONSTRUCTION	
														Start	Finish
1	**No roadway raising (note 2)**														
1.1	no action (19 culvert sets)	7.5	0	1250	177	0.0%	0.0%	1.8%	2.8%	0	N/A	0	N/A	-	-
1.2	spreader swales (30ft x 1000ft - bottom dimensions)	7.5	63195	1371	185	4.6%	0.0%	2.5%	2.4%	187	5155	17	EA	Feb-10	Nov-10
1.3	add culvert sets (19 - 3x5ft dia) with swales **(note 3)**	7.5	63195	1371	188	6.4%	0.0%	3.3%	2.6%	238	14532	73	EA	Feb-10	Aug-11
1.4a	add 1-mile eastern bridge	7.5	63195	1410	203	15.2%	9.0%	26.0%	3.3%	3616	2775	219	EA	Aug-09	Aug-11
1.4b	add 1-mile western bridge	7.5	63195	1410	203	15.2%	9.0%	26.0%	3.3%	4209	2587	266	EA	Jul-10	Nov-12
1.5	reinforce western section of road to 12.75ft (crown) and add 1-mile western bridge	7.5	63195	1410	203	15.2%	9.0%	26.0%	3.3%	4209	>2587+	>266+	EA	Aug-10	Feb-13
2	**Roadway improvements - Crown 11.05ft (4)**														
2.1	reinforce road (low points only)	8.0	63195	1434	239	35.6%	0.0%	1.8%	11.0%	2594		144	EA	Feb-10	Feb-12
2.2.1	reinforce low points, add culvert sets with swales	8.0	63195	1508	251	42.2%	0.0%	1.8%	23.3%	3715	1976	181	EA	Feb-10	Feb-13
2.2.2a	reinforce road, add 1-mile eastern bridge	8.0	63195	1577	274	54.9%	9.0%	26.0%	46.7%	8559	1409	298	EA	Dec-09	Dec-12
2.2.2b	reinforce road, add 1-mile western bridge	8.0	63195	1577	274	54.9%	9.0%	26.0%	46.7%	9154	1398	354	EA	Aug-10	Dec-13
2.2.3	reinforce low points, add 2-mile + 1-mile bridges	8.0	63195	1577	293	65.7%	28.0%	65.0%	63.1%	15681	1111	539	EA	Dec-09	Jun-14
3	**Roadway improvements - Crown 11.55ft (note 4)**														
3.1	reinforce road	8.5	63195	1577	303	71.7%	0.0%	1.8%	76.6%	8621		169	EA	Feb-10	Feb-12
3.2.1	reinforce road, add culvert sets with swales	8.5	63195	1577	316	79.1%	0.0%	1.8%	82.6%	9412	1030	239	EA	Feb-10	Feb-13
3.2.2a	reinforce road, add 1-mile eastern bridge	8.5	63195	1848	340	92.4%	9.0%	26.0%	84.3%	13109	985	319	EA	Dec-09	Dec-12
3.2.2b	reinforce road, add 1-mile western bridge	8.5	63195	1848	340	92.4%	9.0%	26.0%	84.3%	13705	1007	381	EA	Aug-10	Dec-13
3.2.3	reinforce road, add 2-mile + 1 mile bridges	8.5	63195	1869	355	101.1%	28.0%	65.0%	84.3%	18972	955	561	EA	Dec-09	Jun-14
4	**Roadway improvements - Crown 12.75ft (note 4)**														
4.1	reinforce road	9.70	63195	2024	409	131.7%	0.0%	1.8%	84.4%	17543		260	EA	Apr-10	Oct-12
4.2.1	reinforce road, add culvert sets with swales	9.70	63195	2104	417	136.1%	0.0%	1.8%	84.4%	18874	664	346	EA	Apr-10	Oct-13
4.2.2a	reinforce road, add 1-mile eastern bridge (RGRR)	9.70	63195	2181	430	143.8%	9.0%	26.0%	84.4%	22585	685	428	EA	Apr-10	Oct-13
4.2.2b	reinforce road, add 1-mile western bridge (RGRR)	9.70	63195	2181	430	143.8%	9.0%	26.0%	84.4%	23184	709	455	EA	Aug-10	May-14
4.2.3	reinforce road, add 2-mile + 1-mile bridges (RGRR)	9.70	63195	2331	436	146.9%	28.0%	65.0%	84.4%	28361	708	557	Complete	Jun-09	Jun-14
4.2.4	10.7-mile bridge (RGRR)	9.70	63195	4036	472	167.1%	100.0%	100.0%	100.0%	53010		1648	EA	Feb-12	Feb-20
5	**Structural alternatives and/or road realignment (note 4)**														
5.1	northern alignment of Alt 14	9.70	63195	2331	436	146.9%	28.0%	65.0%	84.4%	28361	969	1328	EIS/GRR	Apr-12	Apr-20
5.2	northern alignment with 1-mile bridge	9.70	63195	2181	430	143.8%	9.0%	26.0%	84.4%	23228	1183	1187	EIS/GRR	Apr-12	Apr-19
5.3	northern alignment with 1-mile bridge and relocation of L-67 levee - Crown 13.00ft	9.70	17379	4036 (west) 956 (east)	472	167.1%	9.0%	13.0%	37.1%	4871	4463	751	EIS/GRR	Apr-12	Oct-16
5.4	current alignment with 1-mile bridge and relocation of L-67 levee - Crown 13.00ft	9.70	17379	4037 (west) 956 (east)	472	167.1%	9.0%	13.0%	37.1%	4871	4157	626	EIS/GRR	Aug-12	Feb-16
5.5	pump stations along L-29												EIS/GRR	Aug-13	Aug-21

Notes:

2 Existing road has 19 culvert sets resulting in an average culvert set spacing of ~3000 feet.
3 Reduces the average culvert set spacing to approximately 1500 feet.
4 All road improvements require 3.05 feet between road crest and L-29 design elevation.

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4.4.1 Benefits

The goal of the benefits analysis was to identify the hydrologic and ecological conditions that would occur given the alternatives outlined in this LRR document. These conditions were evaluated and compared to identify potential quantitative benefits for each alternative. The hydrologic analysis is presented first, followed by the ecological performance measures.

4.4.1.1 H&H Spreadsheet Analysis

The spreadsheet model was developed in order to analyze the ecological effects of NESRS that different stage constraints and bridge sizes on Tamiami Trail would produce. This spreadsheet analysis/model looked at the area within NESRS in a simplified manner and the following general assumptions were made for all alternatives (details of the model can be found in Appendix D):

a) The area between Tamiami Trail (north side), the NESRS2 monitoring gage (south side), L-67Ext (west side), and L-31N (east side) could be defined as a simple storage area. As water was added/subtracted to the area the stage would increase/decrease based on a mass balance approach.

b) To compute the inflow volumes historical deliveries were used to prevent having to develop an operational model. This general assumption looked at the total deliveries into ENP (S-12A + S-12B + S-12C + S-12D + S-333) and provided 55 percent of this volume into NESRS as long as the L-29BC was at a lower stage than the constraint for Tamiami Trail. If the L-29 stage was above the constraint flows were assumed to be zero. To smooth out the results for comparison purposes a seven-day rolling average was used to compute the discharges into NESRS. For example, Alternative 1.2, during the period of April 1-14, 1995 computed flows (cfs) based on 55 percent of the volume were: 0, 1356, 0, 0, 1253, 0, 1435, 0, 0, 0, 1252, 0, 1172, and 0. In operations of the real system however a weekly flow volume is targeted to prevent the open/closing of the structure and to maintain a more steady flow. The computed seven-day running average produced results of: 420, 614, 398, 398, 577, 373, 578, 578, 384, 384, 563, 384, 551, and 346.

c) If the flow volume was not delivered to NESRS then it was assumed it was discharged via the S-12s to NWSRS. This assumption produced no net change to the WCA-3A stage compared to historical conditions.

d) Bridge locations did not influence the ability of the spreadsheet model to deliver water. The spreadsheet model only considered topography in a very simplistic manner in regards of allowing flow out of the model and in terms of computing volumetric change. In reality the location of the bridge in conjunction

with major sloughs would increase the volume of water delivered into NESRS. However this determination was beyond the scope of the spreadsheet model. It should be noted a separate analysis was used for Performance Measure 2.C (Flows into NESRS provided via Bridge), refer to Appendix E for a description of the analysis.

e) A linear equation based on flow versus stage difference between L-29BC and NESRS2 was used to compute the stage in L-29BC. The basis for this linear equation was results from the RMA-2 modeling from the 2005 RGRR for Tamiami Trail modifications.

The spreadsheet model does a very good job of interpreting the general trends that increased inflows would produce within NESRS as measured at the NESRS2 monitoring gage. However, stage predictions should not be considered absolutes from this analysis. This analysis is a simplification of a very complicated system developed for a comparison purposes between all of the different alternatives. The spreadsheet analysis was not developed to be a predictive model but rather a comparative analysis. It was developed to be an analysis that incrementally looked at stage increases in the L-29BC and the ability to deliver additional flow volume into NESRS due to that stage increase. The model did predict stage increases in relation to increased flows but should not be considered a predictive model.

4.4.1.2 Performance Measures

Ten performance measures were developed and placed into four groups for convenience of evaluation. Each performance measure had a specific target. The ten performance measures were developed to address the important characteristics of hydrology, ridge and slough processes, vegetation, wildlife and connectivity within ENP. Each of the ten performance measures was assessed for all 27 alternatives. The ten performance measures are as follows:

1A. Average annual flow volumes
1B. One-in-ten year maximum discharge

2A. Number of sloughs crossed by bridges
2B. Difference between average velocity in marsh and average velocity at road
2C. Flows into NESRS provided via bridge

3A. Number of days water depth greater than two feet during wet season peak (indicator of deep marsh habitat conditions)
3B. Number of days water depth greater than three feet during wet season peak (indicator of deep marsh habitat conditions)
3C. Average water depth during wet season peak

4A. Reduction in wildlife mortality
4B. Potential connectivity of WCA-3-B Marsh with NESRS as percent of total project length

Appendix E, Environmental Benefits Analysis, provides an explanation of the rationale for each performance measure, its specific target, and a brief explanation of its meaning.

Most alternatives were expected to provide measurable impacts primarily over a rectangular area of 63,195 acres, located south of Tamiami Trail, bounded on the west side by the L-67 Extension (near S-333) and the east side by the L-31N Levee and the 8.5 SMA. The southern limit was defined as an east-west line connecting the southern end of L-67 Extension to 8.5 SMA. The area is depicted with the red outline in ***Figure 4-2*** and ***Figure 4-3***.

The benefits area for the "Blue Shanty" alternatives, 5.3 and 5.4, were smaller, because all flow would have been contained in the section of NESRS between the L-67 Extension and a levee that would be constructed along the Blue Shanty Canal. The benefits area for these two alternatives was 17,379 acres. This benefit area for the two alternatives may actually extend further south. In theory the area south would experience similar benefits from the south point of the L-67 Extension Levee across the ENP to the 8.5 SMA. The benefited acreage for each alternative is shown in ***Table 4-3***.

4.4.1.3 Links between Hydrology and Ecological Performance

As cited earlier in the report, this study team was tasked with immediately improving water deliveries and adopting an adaptive management approach toward restoring flows to ENP. The ultimate purpose of the water deliveries is to result in a positive ecological response. Science cannot accurately predict how a dynamic ecosystem will react to a change in hydrology. Therefore, the best method available involves "proxies" and "indicators" which the team believes will produce positive results for the ecosystem. The performance measures used in this LRR, characterized in Appendix E as "hydro-ecological performance measures," use past studies as well as the best professional judgment of a multi-agency team to predict when positive changes will occur. It is because of this uncertainty that an adaptive management approach is crucial to restoring the Everglades.

Some of the performance measures used in this analysis do not imply a direct relationship between hydrology and ecology. For example, the PMs "average annual flow volumes" and "difference between average velocity in marsh and average velocity at road" are hydrologic measures which the biologists and ecologists on the team felt would represent positive outcomes for the total ecosystem. The team chose hydrologic targets as surrogates for marsh and

slough habitats, as this is widely accepted and there are numerous published reports relating the two.

The mechanisms that control the formation and maintenance of ridges and sloughs are still poorly understood (Science Coordination Team 2003, McVoy and Tarboton 2004). Nevertheless, several models of ridge and slough topography have been proposed (McVoy and Tarboton 2004, Ross et al. 2006, Givnish et al. 2007). McVoy and Tarboton (2004) stress that ridge and slough topography is a function of water depth, water depth variation (seasonal fluctuation), flow velocity, and flow direction. Consequently, the team felt that these factors are reasonable proxies for alternative analysis.

There are, however, three performance measures that are directly linked to a species. The subset of performance measures entitled "Restore Vegetative Communities" includes measures of number of days at certain water depths during the rainy season, as well as average water depths. These measures are based on optimum conditions for the white water lily (Nymphaea odorata), a species characteristic of open sloughs in the Park. These conditions are based on research from Dr. Jenny Richards' mesocosm studies at Florida International University (Bi-annual Report for CA H5297-05-0013 Hydrologic Requirements of Aquatic Slough Vegetation, January 22, 2008).

NESRS historically was part of the ridge and slough ("corrugated") Everglades landscape. Sloughs are conspicuous and major landscape features in the southern Everglades and are the main pathway of water flow through the natural Everglades. The slough community is present in areas with the longest hydroperiods and the deepest water that rarely dries out. It also has a distinct plant community which is a mixture of floating, submerged species and sometimes emergent species.

A dominant and characteristic species of pre-drainage native sloughs is the white water lily. Over the past 40 years of hydrologic isolation from the ecosystem to the north, NESRS has largely converted to a drier community of mixed sawgrass with very little white water lily. White water lily is more abundant in deeper slough habitats and areas less subject to drydown events. Paleoecological studies indicate that pre-drainage ENP slough communities were once dominated by white water lily and banana lily prior to the widespread artificial drainage of slough communities. Many scientific studies and field observations indicate areas with conditions with deep water and few drydown events are where white water lily does better than other plants and is more abundant than other species. The vegetation suitability performance measures measure the hydrologic conditions that favor slough vegetation, particularly the white water lily, and rank favorably those alternatives that are best able to

mimic those conditions. The other performance measures represent hydrologic targets used as surrogates for marsh and slough habitat improvement.

4.4.2 Cost Analysis

Data for the initial design, construction/implementation and land acquisition costs for all 27 alternatives have been developed through engineering design, cost estimation and real estate appraisal efforts. Total construction cost used in the cost analysis of each alternative includes labor and materials costs for completing the structure(s). Total project cost is the sum of total construction cost (TCC), PED cost, S&A cost, real estate cost and escalation.

The 30 percent design cost estimates for the selected plan from the 2005 RGRR served as the starting point for the LRR cost estimates. From this, a parametric cost model was constructed to allow comparable estimates to be developed for all the alternatives.

Cost Risk Analysis. In September 2007, the USACE mandated the use of risk and uncertainty analysis for major projects. Cost risk analysis is the process of identifying and measuring the cost and schedule impact of project uncertainties on the estimated total project cost. When considerable uncertainties are identified, cost risk analysis can establish the areas of high cost uncertainty and the probability that the estimated project cost would or would not be exceeded. The 90 percent confidence level was selected as the appropriate level for the TCC. This means that there is a 90 percent chance that the final cost for this project (at fiscal year-08 pricing levels) would be equal to **or less** than this cost. This is an extremely important point and is different than how USACE project costs have traditionally reported.

Escalation. Generally, civil works projects are escalated using annual indices in accordance with the Civil Works Construction Cost Index System. The indices are indicators of inflation. The indices are used only for near-term escalation for two years or less. Beyond that timeframe it is necessary to evaluate market conditions. The 90 percent TCC estimates were escalated to the mid-point of construction, and then adjusted based on recent inflation trends in the construction industry and the anticipated construction schedule for each alternative. Since 2003, there has been unprecedented inflation in the construction industry due to rising oil prices, huge demand from overseas economies, natural disasters, and the continuing globalization of the construction industry.

Costs of alternatives are estimated at October 2007 price levels (refer to ***Table*** 4-3 for a summary of costs and Appendix C for in-depth discussion of costs). The costs in ***Table 4-3*** include market conditions escalation to the midpoint of construction.

From the cost analysis of the alternatives, the following points are emphasized:

- Costs increase at two points, at every stage increase and as opening size increases.
- Cost is associated with time of construction, both in terms of planning/design and actual construction timelines. Escalation rates observed in Florida are higher than in many other sections of the country. Plans that have shorter implementation timelines have less escalation—they are relatively less expensive.
- Costs are highly dependent on construction materials, especially asphalt and concrete. In general, road work is less expensive than bridge construction; therefore plans that limit bridge lengths tend to be less expensive.
- First costs include the risks and construction techniques necessary for constructing a project within ENP, which is a sensitive environment.
- Risk and uncertainty have been integrated into the cost analysis.

4.4.3 Screening

The screening of the LRR alternatives was based on both performance and cost criteria. These factors were used to remain in compliance with the language of the 2007 WRDA Managers' Report (Section 1) as well as the broad guidance provided by senior policy personnel within the USACE and the DOI. Initially, the guidance provided to the team was based on complying with two over-arching principles, one from the USACE and the other from DOI. USACE guidance was to identify an alternative at a cost less than the 2005 RGRR Selected Plan and not exceeding an initial upper limit cost of $300 million. DOI guidance was less specific and included the need to identify an alternative having an appropriate level of project performance while being cost effective. No upper cost threshold was provided to DOI members of the LRR team. As will be seen later in this section, this general guidance was sufficient to screen the alternatives with minor modifications in response to the expressed desires of the cooperating agencies and/or the local sponsor participating in the development of this report.

Using the broad guidance described above, the LRR team screened the LRR alternatives using a subset of the performance measures described in the Benefits Analysis Section (Section 4.4.1) as well as the estimates of the total project costs provided in ***Table 4-3***. The performance measures selected for use in the screening were those measures which provided the greatest ability to segregate the alternatives based on relative ecological and hydrological performance as well as being representative of measures requiring some minimum level of performance for an alternative to be considered acceptable. The screening strategy employed was to apply the selected ecological and hydrological performance measures sequentially and then subject the remaining

alternatives to a final screening based on the project costs. The ecological and hydrological performance measures used for this process are found in ***Table 4-4*** and are listed in their order of application in the screening process, including the threshold level of performance used for the acceptance/rejection of a given alternative:

TABLE 4-4: ECOLOGICAL AND HYDROLOGICAL PERFORMANCE MEASURES USED FOR SCREENING

Screening Priority	Measure	Hydrological/Ecological Measure Description	Screening Threshold (% above No Action)
1	1A	Average annual flow volumes	<= 20%
2	2B	Difference between average velocity in the marsh and average velocity at road	<= 20%
3	4B[1]	Potential connectivity of WCA-3B marsh with NESRS as percent of total project length	<=5%
4	3A	Hydrologic Suitability for Slough Vegetation	<=20%

[1]Note: this performance measure was originally PM 1B

These performance measures, used in the order stated in ***Table 4-4***, provide a needed combination of hydrologic performance: (1 and 2), marsh connectivity (3), and downstream ecological response (4) for the team to be confident that the screening process would provide an acceptable suite of alternatives following their sequential application.

Results of the iterative screening are described in detail below:

Screening of Alternatives Based on Average Annual Flow Volume Performance (Screening Priority 1). The initial screening of the LRR alternatives was conducted using the average annual flow volume performance measure. The relative performance of each of the alternatives is provided in ***Figure 4-8,*** and includes the threshold of a minimum level of performance of a 20 percent increase in discharge above the No Action Alternative. Alternatives which met this minimum level of performance were all alternatives in Categories 2, 3, 4, and 5. All alternatives in Category 1, which maintained the L-29 canal stage at 7.5 feet, were eliminated from further consideration. This includes alternatives with additional culverts and bridging; therefore, the ability to improve flows into NESRS appears less dependant on openings through the roadway and more dependant on the ability to increase the stage in the L-29 Canal. All alternatives having an L-29 stage greater than or equal to 8.0 feet were retained for subsequent screening.

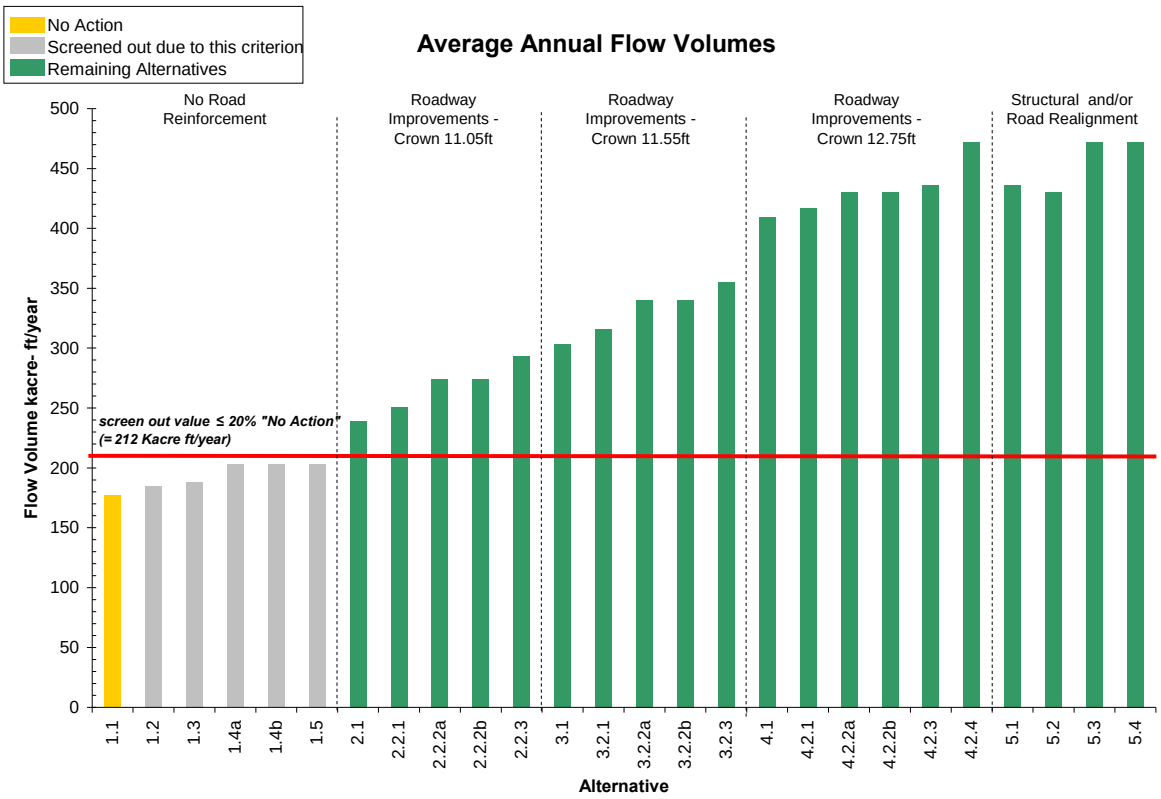

FIGURE 4-8: SCREENING RESULTS FOR AVERAGE VOLUME PERFORMANCE

Screening of Alternatives Based on Difference between Average Velocity in the Downstream Marsh and Average Velocity at Road (Screening Priority 2). Flow velocities different from the natural marsh conditions can result in modifications to the landscape, including unnatural nutrient loading, vegetation cover and soil characteristics. Alternatives were next assessed for their ability to provide slower velocities near the road (approaching marsh water velocities). Current average marsh water velocities are ~0.024 ft/sec compared to current average velocities at the road of ~1.33 ft/sec. To prevent potential erosion immediately downstream of road openings and decrease the deposition of sediment fans inside the Park, velocities of ~1.0 ft/sec or less are desired. The desired velocity approximates 20 percent increase or level of performance compared to the No Action Alternative. Application of this screening measure resulted in the relative performances depicted in ***Figure 4-9*** and resulted in the elimination of an additional six alternatives (2.1, 2.2.1, 3.1, 3.2.1, 4.1, and 4.2.1). Essentially, this screening measure eliminated all alternatives that did not have at least one bridge span within the road alignment. All remaining alternatives that had bridge spans were retained (Alternatives 2.2.2a, 2.2.2b, 2.2.3, 3.2.2a, 3.2.2b, 3.2.3, 4.2.2a, 4.2.2b, 4.2.3, 5.1, 5.2, 5.3, and 5.4) for subsequent screening. It should also be noted that alternatives with multiple bridge spans and larger span lengths performed better than alternatives with single bridges of relatively shorter bridge span length.

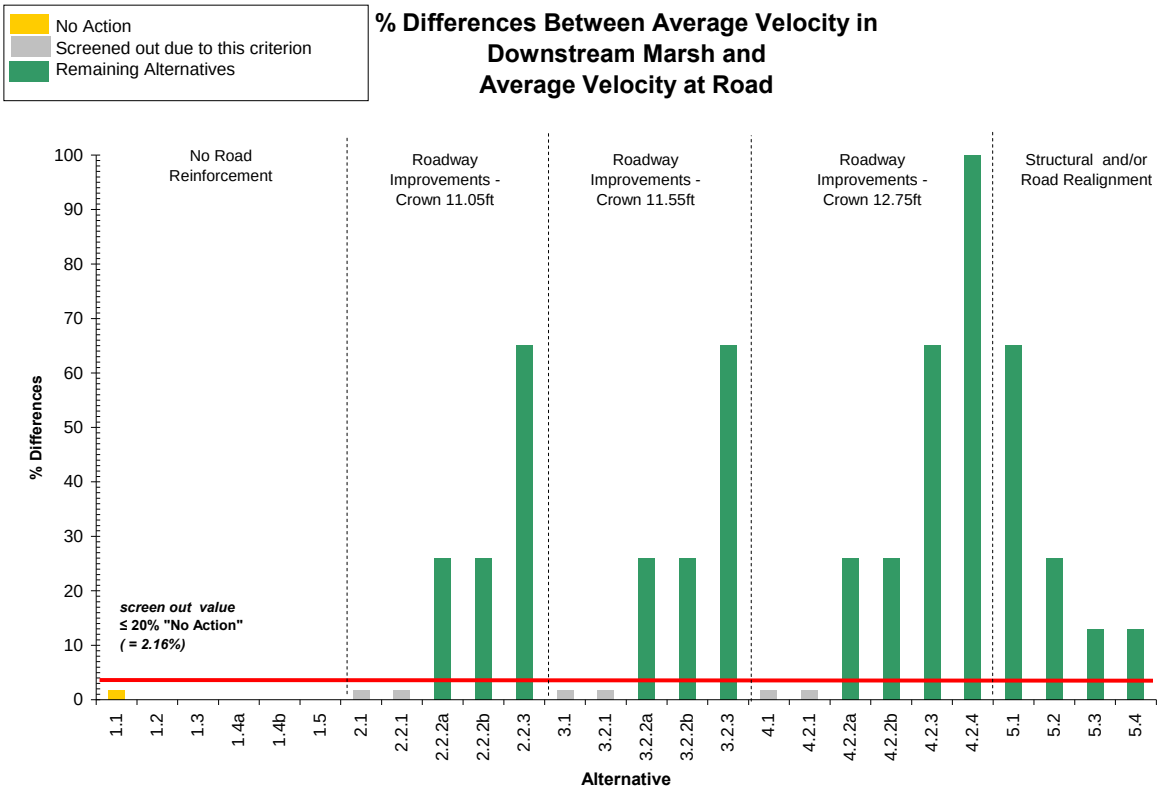

FIGURE 4-9: SCREENING FOR AVERAGE VELOCITY PERFORMANCE

Screening of Alternatives Based on Connectivity of WCA-3B Marsh and NESRS (Screening Priority 3). Connectivity performance is a measure of the degree of unimpeded natural overland flow through the marsh. The remaining alternatives were next screened for connectivity based on a minimum performance of five percent more than the No Action Alternative for marsh connectivity. As stated in earlier sections of this report, connectivity is considered as one of the primary objectives of marsh ecosystem restoration. Application of this screening measure (***Figure 4-10)*** did not result in the elimination of any additional alternatives that remained after step 2 but did affirm the need to eliminate the alternatives that failed to meet the minimum level of performance of the previous screening criteria. For example, Alternatives 1.2, 1.3, 2.1, 2.2.1, 3.1, 3.2.1, 4.1, and 4.2.1 exhibited a level of connectivity performance below the five percent threshold for this screening criterion. Therefore, Alternatives 2.2.2a, 2.2.2b, 2.2.3, 3.2.2a, 3.2.2b, 3.2.3, 4.2.2a, 4.2.2b, 4.2.3, 5.1, 5.2, 5.3, and 5.4 were retained for further screening.

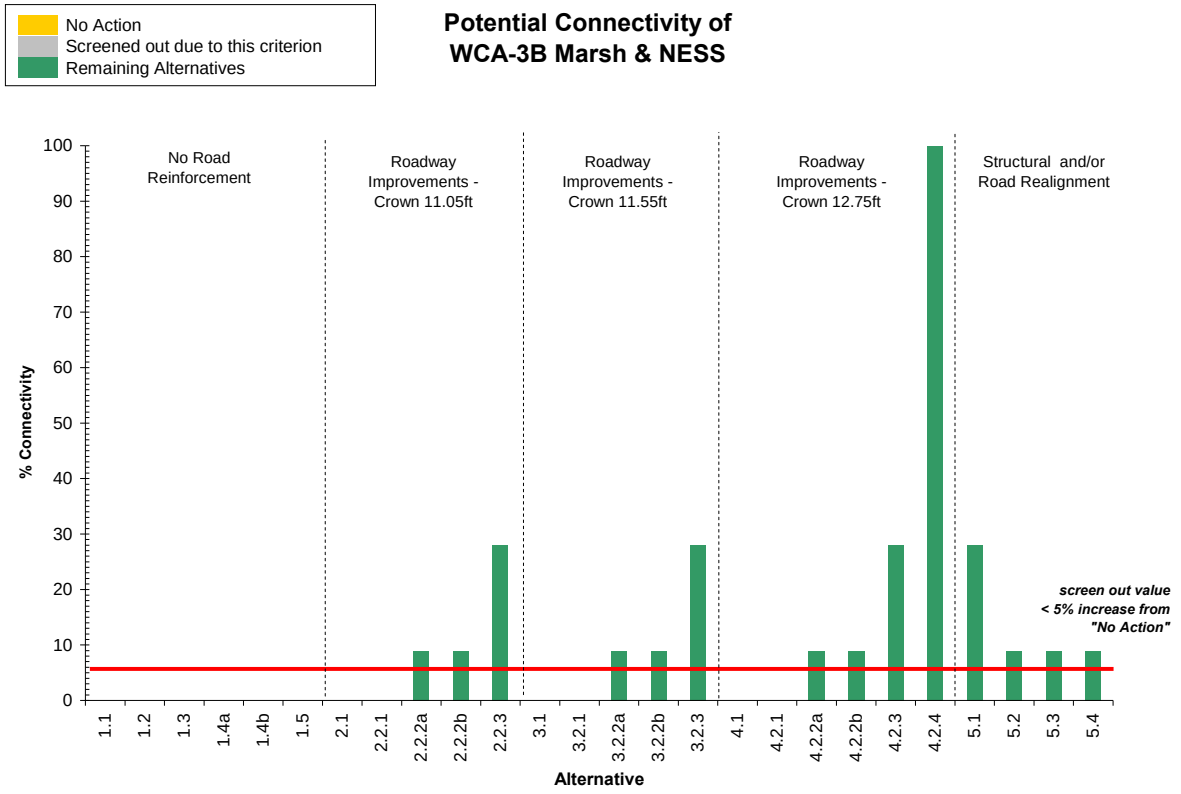

FIGURE 4-10: SCREENING FOR MARSH CONNECTIVITY PERFORMANCE

Screening of Alternatives Based on Hydrologic Suitability for Slough Vegetation (Screening Priority 4). This screening criterion is based on the need to attain water depths within the slough landscape of sufficient depth and duration to promote and sustain vegetation communities that covered the slough landscape in ENP historically. The screening measure produced similar results as the criterion for marsh connectivity. All alternatives that were retained following screening by screening priorities 1, 2, and 3 were again retained following the application of this screening priority using a minimum threshold of performance of 20 percent greater than the No Action Alternative (***Figure 4-11***). Alternatives 2.2.2a, 2.2.2b, 2.2.3, 3.2.2a, 3.2.2b, 3.2.3, 4.2.2a, 4.2.2b, 4.2.3, 5.1, 5.2, 5.3, and 5.4 were retained but also affirmed the results of the application of the earlier screening criteria when Alternatives 1.2, 1.3, 2.1, 2.2.1, 3.1, 3.2.1, 4.1, and 4.2.1 exhibited a low level of performance for marsh connectivity.

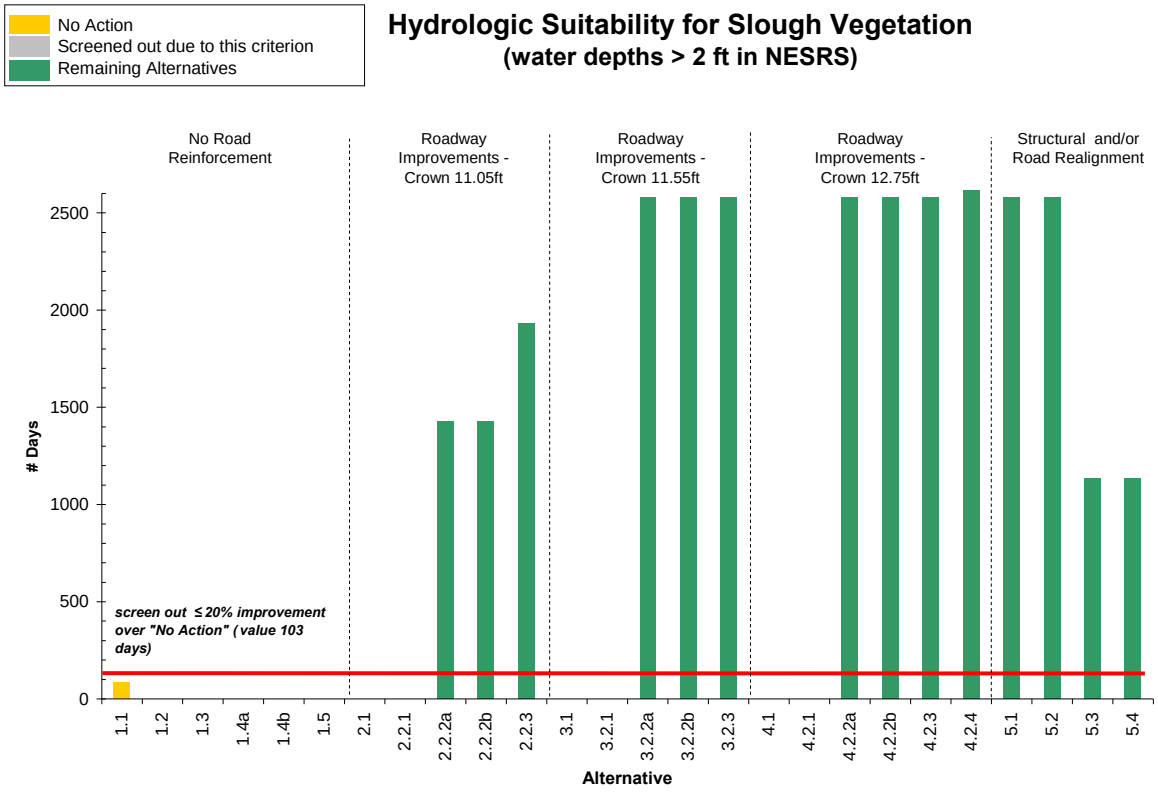

FIGURE 4-11: SCREENING FOR HYDROLOGIC SUITABILITY FOR SLOUGH VEGETATION PERFORMANCE

The results of the screening of the LRR alternatives using the hydrological and ecological performance measures indicated several important findings. First, those alternatives with lower canal stage in L-29 would likely not produce the flows or the water levels necessary for a satisfactory level of restoration

consistent with the objectives of the MWD Project. Second, only the alternatives that contained bridge spans provide potential ecological connectivity and flows that are likely to approximate natural marsh conditions.

Screening of Alternatives Based on Cost. Based on these results, the remaining alternatives (2.2.2a, 2.2.2b, 2.2.3, 3.2.2a, 3.2.2b, 3.2.3, 4.2.2a, 4.2.2b, 4.2.3, 5.1, 5.2, 5.3, and 5.4) were then subjected to the final screening priority-cost. Identification of the appropriate threshold for cost screening was difficult due to the lack of a unified and specific view from policy personnel in the USACE and DOI. Initially, the guidance from the USACE to the LRR team was to use a $300 million threshold as this was interpreted to be the upper limit of support from Congress for the Tamiami Trail component of the MWD Project. This limit was based on the assumptions that the authority of the MWD Project was limited and that additional modifications were also authorized for implementation under the CERP authority. Following public scoping of the LRR alternatives and the subsequent sharing of the preliminary results of the hydrologic and ecologic performance of the LRR alternatives, it became evident that many of the alternatives exhibiting a significantly higher level of performance were alternatives with project costs slightly higher than the initial $300 million threshold. Many of these alternatives were also identified by stakeholders as their preference for implementation. Therefore, based on input from the cooperating agencies and the local sponsor for the project, the technical LRR team elected to raise the cost threshold to $400 million to allow for the review of alternatives exhibiting significantly higher levels of performance than the pervious $300 million threshold. Additional considerations were included in the selection of this threshold cost. The team did not anticipate that $400 million or even $300 million would be approved. The team knew that the screening cost estimates (Table 4-3) were conservatively high and expected that additional design would reduce the costs anywhere from $20 million to $100 million. The threshold took into account this potential cost reduction. $400 million was considered high enough to retain alternatives with a reasonable potential to be funded after the savings and low enough to screen most alternatives that were so costly that they would not be fundable.

The results of the screening of the remaining alternatives with respect to a $400 million cost threshold are depicted in ***Figure 4-12***.

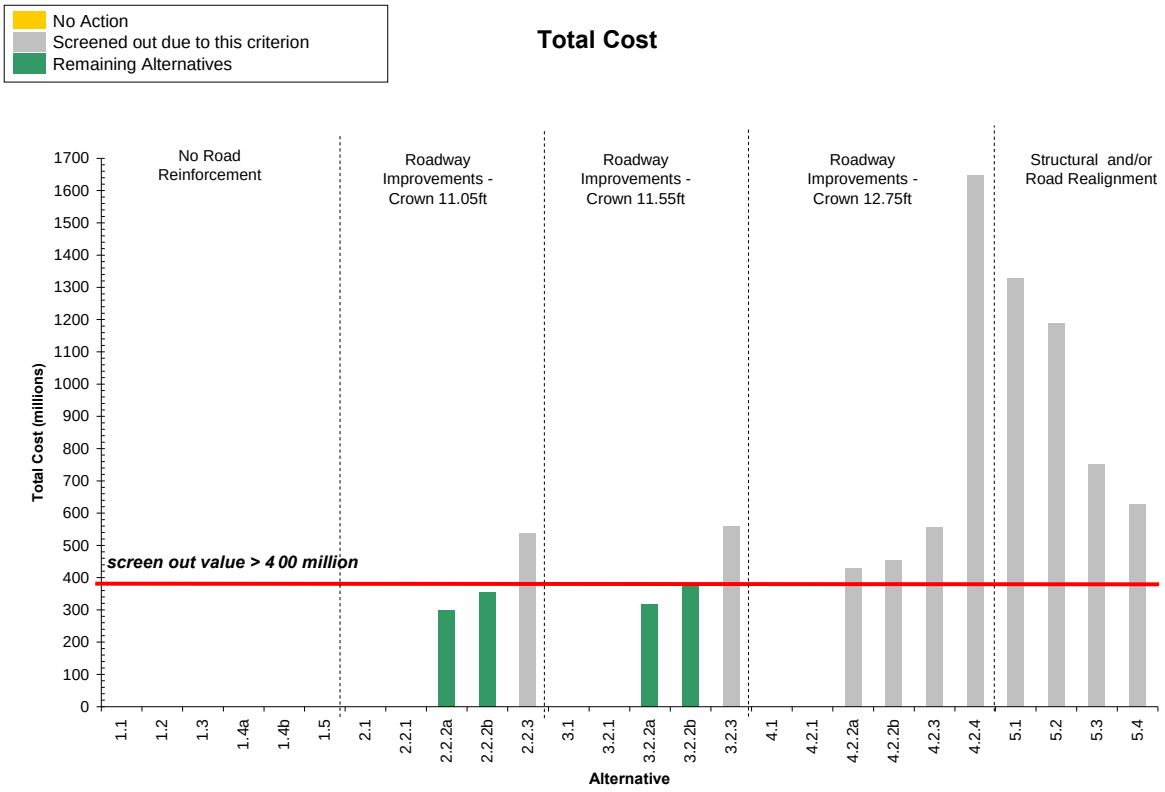

FIGURE 4-12: SCREENING FOR COST PERFORMANCE

Clearly, cost is the most important screening criterion in determining the final suite of LRR alternatives. Ten of the remaining fourteen alternatives were eliminated from further analytical considerations due to the application of the $400 million cost threshold; this includes the 2005 RGRR Environmentally Preferred Alternative - the 10.7-mile bridge plan (Alternative 17 of the RGRR and Alternative 4.2.4 of this LRR). The most important result of using this screening measure is that all of the highest performing alternatives were eliminated. Alternatives 2.2.3, 3.2.3, 4.2.2a, 4.2.2b, 4.2.3, 5.1, and 5.2 consistently exhibited higher level of performance for volume, marsh velocity, connectivity, and slough vegetation suitability than the alternatives which remain following the screening using the $400 million cost threshold. Many of the alternatives eliminated due to cost have features that include more bridging, longer spans for the bridges, and roadway modifications which allow for higher water levels in the L-29 Canal and allow for full restoration of NESRS. The alternatives remaining following the application of all of the screening measures, including cost, are Alternatives 2.2.2a, 2.2.2b, 3.2.2a, and 3.2.2b. This final suite of alternatives would be evaluated more fully in subsequent sections using the remaining performance measures found in Section 4.4.1. It is the opinion of the LRR team that the resulting alternatives meet the general guidance provided by the USACE and DOI for the identification of a cost effective alternative less

costly than the 2005 RGRR Selected Plan but still providing a level of performance consistent with the objectives of the MWD Project.

Sensitivity of Screening Thresholds. The team performed a simple sensitivity analysis of the effect of changing screening thresholds. The screening criteria used by the team are: volume 20%, velocity 20%, connectivity 5%, and depth-days for vegetation 20%. Four alternatives remain after screening: 2.2.2a, 2.2.2b, 3.2.2a, and 3.2.2.b. The sensitivity analysis looked at dramatic changes in the screening thresholds but did not see dramatic changes in the results of screening.

1. Remove the connectivity criterion from the analysis and keep the remaining three criteria at 20%; the same four alternatives would remain.
2. Remove the connectivity criterion and **double** the remaining three thresholds from the current 20% to 40%; the same four alternatives would remain.
3. Remove the connectivity criterion and **reduce by one-quarter** the remaining three thresholds from the current 20% to 15%; the same four alternatives would remain.
4. Remove the connectivity criterion and **reduce by half** the remaining three thresholds from the current 20% to 10%; seven alternatives would be retained - the same four alternatives as the original scenario plus three additional alternatives. The new alternatives would be 1.4a (1-mile eastern bridge, 7.5 stage), 1.4b (1-mile western bridge, 7.5 stage), and 1.5 (1-mile western bridge and raise part of road, 7.5 stage). These new alternatives would have been added due to the relaxation of average annual volume thresholds.

4.5 Evaluation and Comparison of Final Alternatives

After further evaluation to determine the extent to which the alternative plans would meet project objectives and taking into consideration opening size, stage increases and acceptable project costs, four action alternatives were identified in addition to the No-Action Alternative. The final array of alternatives is:

- 1.1 No-Action
- 2.2.2a Raise canal stage to 8.0 feet, reinforce road, one-mile eastern bridge
- 2.2.2b Raise canal stage to 8.0 feet, reinforce road, one-mile western bridge
- 3.2.2a Raise canal stage to 8.5 feet, reinforce road, one-mile eastern bridge
- 3.2.2b Raise canal stage to 8.5 feet, reinforce road, one-mile western bridge

Versions of these four action alternatives were also previously considered in the 2005 Report. It is expected that the four action alternatives listed above can provide a 55-92 percent increase in average annual water flows to NESRS. Since the one-mile eastern bridge is a portion of the previously selected plan, the geotechnical survey data and the intermediate plans and specifications can be used without any loss of time having to redo them.

4.5.1 Ecological Performance

Table 4-5 displays the performance measures and habitat units (HUs) for the four final alternatives. These values are the same as in Table E-3 of Appendix E, but are reproduced here for convenience.

TABLE 4-5: PERFORMANCE MEASURES FOR FINAL ALTERNATIVES

Performance Measure	1.1 No Action	2.2.2a Stage to 8.0, 1-mile Bridge East, Reinforce Road	2.2.2b Stage to 8.0, 1-mile Bridge West, Reinforce Road	3.2.2a Stage to 8.5, 1-mile Bridge East Reinforce Road	3.2.2.b Stage to 8.5, 1-mile Bridge West, Reinforce Road,
1A. Average Annual Flow Volume (acre-feet)	176,559	273,565	273,565	339,703	339,703
1B (re-labeled as 4B)					
1C. One in ten year maximum discharge (cfs)	1146	1416	1416	1642	1642
2A. Number of sloughs crossed by opening	0	2	2	2	2
2B. Ratio between average velocity in marsh and average velocity at road (%)	1.8	26	26	26	26
2C. Flows into NESRS provided via bridge (%)	0	11	20	11	20
3A. Total number of days at NESRS-1 and NESRS-2 with water depth >2 ft during growing season peak	86	1428	1428	2578	2578
3B. Total number of days at NESRS-1 and NESRS-2 with water depth >3 ft during growing season peak	0	3	3	7	7
3C. Average water depth at NESRS-1 and NESRS-2 during growing season peak (ft)	1.3	1.66	1.66	1.88	1.88
4A. Reduction in wildlife mortality (number deaths avoided per year)	0	261	261	261	261
4B. Potential connectivity of WCA-3B and NESRS (% of total length)	0	9	9	9	9
Average Annual Habitat Units (HU)	9,103	17,662	18,257	22,212	22,808
Average Annual HU lift (50 year analysis)	0	8,559	9,154	13,109	13,705

Table 4-6 summarizes the performance, compared to no-action, of the final four alternatives.

Ecological performance indices were calculated as explained in detail in Appendix E by setting the maximum of each performance measure to 100 percent and expressing "lift" of each alternative in terms of percent achievement of that maximum (***Table E-4***). Normalization of all outputs allowed the team to average outputs and multiply the index by affected acres, providing benefits expressed in (HUs). HU output was further adjusted to account for the time required for vegetation to change, and calculated for a 50 year period of analysis.

TABLE 4-6: SUMMARY PMS AND HU LIFT

OUTPUT OF ALTERNATIVES IN AVERAGE ANNUAL HABITAT UNITS LIFT ABOVE THE NO-ACTION ALTERNATIVE

ALTERNATIVE	Area of Benefits (Acres)	Volume increase %	Velocity Differences, Marsh and Opening	Time with Depths > 2 feet	Avg. Annual Lift (HU)
1. (No Action)	63195[1]	0	0	0	0
2.2.2.a Reinforce road 1/2 foot, eastern bridge	63195	54.9	26	46.7	8559
2.2.2.b Reinforce road 1/2 foot, western bridge	63195	54.9	26	46.7	9154
3.2.2.a. Reinforce road 1 foot, eastern bridge	63195	92.4	26	84.3	13109
3.2.2.b. Reinforce road 1 foot, western bridge	63195	92.4	26	84.3	13705

1. A few performance measures were applied over a smaller area. Reference Appendix E for details.

The performance measures that appear most indicative of potential ecosystem restoration are those for slough vegetation suitability and wet season average water levels (PMs 3A, 3B and 3C). Alternatives in the "2" group that would raise stage constraints by only one-half foot increased the frequency of occurrence of deep water stages more than two feet in the marsh dramatically, by 47 percent. Even greater benefits, providing 84 percent stage improvements over no-action, were predicted for the bridge alternatives that would raise the stage constraint by one foot (the "3" group). This appears to indicate that conditions favorable for maintenance of deep slough vegetation would be much more frequent under the one-foot rise alternatives than under the one-half foot

rise alternatives (the "threes" rather than the "twos"). Further, the 84 percent improvement at the "3" level means that these two alternatives are already capable of providing 84 percent of the re-hydration potential of the vegetation suitability two-foot stage target. (100 percent was provided only by the 10.7 mile reinforced road). The second flooding performance measure, number of times the marshes were flooded at three-feet or greater over the period of record, did not show dramatic changes. Apparently achieving these favorable slough-like flooding levels, which might facilitate re-conversion of deep marsh to open water sloughs, required more extreme stage increases at the road than would be provided by the final alternatives. Such high stages (greater than 8.5 feet at Tamiami Trail) occur infrequently at present, but are expected to become more frequent in CERP implementation. As stated elsewhere, the bridge design under all alternatives would allow peak stages of up to 9.7 feet, and only the road would require additional mitigation as stages increase to 9.7 feet under CERP flow conditions.

Stages in the marshes during the average wet season peak are indicated by PM 3C. Wet season peak depth is now approximately 1.3 feet on average. The alternatives with a one-half foot stage increase and a one-mile bridge increased wet season peak depth, on average, to 1.66 feet; the two alternatives with a one-foot stage increase and bridges showed a further increase to an average marsh depth of 1.88 feet. These values complement the performance measures for the frequency of very high stages, showing more average year-on-year performance. What this output may mean is that all of the four final alternatives can increase average depths in Everglades marshes, and the Alternatives 3.2.2.a and 3.2.2.b can do so rather dramatically.

All four final alternatives provided similar water velocity changes in the marsh south of the road, indicating better maintenance of ridge-and slough profiles. To further reduce damaging velocity changes causing scour and deposition it would be necessary to gap the road in additional places.

4.5.2 Cost

Once the final alternatives were identified, their cost estimates were revisited. This additional effort and analysis was reasonable to perform for the final array of alternatives, but it was not feasible to perform this high level of effort for all 26 action alternatives of the initial array. A major goal of the re-look was to reduce construction costs and mitigate risk. The following cost saving options were evaluated for the final suite of alternatives. Not all of these options are applicable to all alternatives.

- Reduce asphalt placement based on revised criteria received January 2008 from FDOT
- Additional Temporary Right of Way for Construction from ENP

- Reduction in Low Chord Height for Bridge Inspection per FDOT
- Obtain Fill Material from L-31(N) Spoil Mounds from SFWMD
- There is the possibility that the scheduled contract award date can be moved to October 2008. This option can be applied to the eastern one-mile bridge but not to the western one-mile bridge. This would substantially reduce future escalation.

The revised total project cost estimates in ***Table 4-7*** include all applicable cost savings options for each alternative. Construction costs incorporate risk analysis procedures and represent the 90 percent confidence not likely to exceed level. The estimates are based on October 2007 price levels. The costs in this table do not include PED costs that accrued during previous Tamiami Trail study efforts as these are considered sunk costs for evaluation purposes. The costs also do not include escalation. Plan formulation costs, as a matter of policy, do not include escalation. By applying the cost saving options and removing PED and escalation, the revised total cost estimates for the final four alternatives do not match, and are lower than the cost estimates presented in ***Table 4-3*** for these alternatives.

TABLE 4-7: TOTAL COST ESTIMATES OF THE FINAL ALTERNATIVES

	2.2.2a	2.2.2b	3.2.2a	3.2.2b
Construction				
Construction Subtotal (includes bridge, road removal, transitions, road, maintenance of traffic, and mobilization)	$126,000,000	$145,100,000	$154,800,000	$188,200,000
PED	$0	$0	$0	$0
EDC (2%)	$2,500,000	$2,900,000	$3,100,000	$3,800,000
S/A (8.5%)	$10,700,000	$12,300,000	$13,200,000	$16,000,000
Real Estate	$5,900,000	$5,900,000	$5,900,000	$5,900,000
Total Cost	**$145,100,000**	**$166,200,000**	**$177,000,000**	**$213,900,000**

4.5.3 Cost-Effectiveness/Incremental Cost Analysis for the Final Array of Alternatives

The purpose of a cost effective/incremental cost analysis (CE/ICA) is to determine the most economically efficient alternatives for producing a given output, which in the case of Tamiami Trail is measured in habitat functionality. Cost effectiveness analysis begins with a comparison of the costs and outputs of alternative plans to identify the least cost plan for every level of output considered. Alternative plans are compared to identify those that would produce greater levels of output at the same cost, or at a lesser cost, as other alternative plans. Alternative plans identified through this comparison are the cost effective alternative plans. Through the incremental analysis, cost effective plans are compared by examining the additional (incremental) costs for the additional (incremental) amounts of output produced by successively larger cost effective plans. The plans with the lowest incremental costs per unit of output for successively larger levels of output are the "Best Buy" plans. The results of these calculations and comparisons of costs and outputs between alternative plans provide a basis for addressing whether the additional outputs are worth the costs incurred to achieve them.

The final array of alternative plans for this project consisted of two alternatives that would increase the stage in the L-29 Canal to 8.0 feet and two alternatives that would increase the stage to 8.5 feet. All other management measures and alternatives were screened from further consideration as a result of previously described evaluation. ICA of the system-wide effects of the final array of plans was performed using IWR Plan software. This analysis is based on and follows guidance from the USACE Institute for Water Resources' publication, Evaluation of Environmental Investment Procedures Manual, Interim: Cost Effectiveness and Incremental Analyses, May 1995, IWR Report #95-R-1. Costs for the final array of alternatives are based upon construction costs with 90 percent confidence and also incorporated expected cost savings measures and include post-authorization PED and construction costs, interest during construction, as well as operation and maintenance costs after construction.

4.5.3.1 Average Annual Habitat Units

In ecosystem restoration projects, CE/ICA requires a comparison of average annual costs and average annual outputs (benefits). Average Annual Habitat Units (AAHU) is a measure of benefits that integrates many characteristics of the ecosystem into a single value. The average annual outputs were calculated as the difference between AAHU with-plan and AAHU without-plan (No Action) over the period of analysis (through year 2060). This difference is the lift, gain, or benefit associated with implementing the alternative. All of the outputs were calculated on an average annual basis to account for the fact that several years may be required for full attainment of the functional capacities to be realized. The calculations are further described in Appendix E. The AAHU lifts for the final alternatives are shown in ***Table 4-8***.

TABLE 4-8: AVERAGE ANNUAL HABITAT UNIT LIFT

Alternative	Average Annual Project Habitat Units
Alternative 2.2.2a	8,559
Alternative 2.2.2b	9,154
Alternative 3.2.2a	13,109
Alternative 3.2.2b	13,705

4.5.3.2 Average Annual Cost

The planning level cost estimate for the alternatives include; construction, lands, and construction management and were conducted utilizing a 90 percent confidence level, to minimize the potential for underestimating costs. Plan evaluation was analyzed using the 90 percent confidence level, but a separate analysis was conducted utilizing lower confidence levels (50 and 80 percent) to determine the sensitivity of the evaluation to the varying cost estimates. Data for initial construction/implementation, land acquisition, and periodically recurring costs for OMRR&R, have been developed through engineering design and cost estimation, and real estate appraisal efforts.

For purposes of this report and analysis, national economic development (NED) costs, as defined by USACE, are expressed in October 2007 (FY 08) price levels, and are based on costs estimated to be incurred over a 50 year period of analysis, annualized utilizing the current federal discount rate of 4 7/8 percent. Costs of a plan represent the value of goods and services required to implement and operate and maintain the selected plan. These costs are included in ***Table 4-9*** and were used in the CE analysis of the alternatives.

The costs in this section of the main report include potential cost savings measures, but do not represent the total cost of the project with escalation. Plan formulation costs, as a matter of policy, do not include escalation. These costs do not include PED costs that accrued during previous Tamiami Trail study efforts as these are considered sunk costs for evaluation purposes.

TABLE 4-9: NATIONAL ECONOMIC DEVELOPMENT COSTS OF FINAL ARRAY OF ALTERNATIVES*

Cost Component	2.2.2a	2.2.2b	3.2.2a	3.2.2b
Construction	$126,000,000	$145,100,000	$154,800,000	$188,200,000
EDC (2%)	$2,500,000	$2,900,000	$3,100,000	$3,800,000
S/A (8.5%)	$10,700,000	$12,300,000	$13,200,000	$16,000,000
Total Construction Cost	**$139,200,000**	**$160,300,000**	**$171,100,000**	**$208,000,000**
Lands	$5,900,000	$5,900,000	$5,900,000	$5,900,000
Total Implementation Cost	**$145,100,000**	**$166,200,000**	**$177,000,000**	**$213,900,000**
Interest During Construction				
Construction	**$6,840,000**	**$7,880,000**	**$10,600,000**	**$12,880,000**
Lands	**$670,000**	**$670,000**	**$670,000**	**$670,000**
Total Economic Investment	**$152,610,000**	**$174,750,000**	**$188,270,000**	**$227,450,000**
Amortized Investment Cost	**$8,199,000**	**$9,388,000**	**$10,120,000**	**$12,219,000**
OMRR&R	$30,000	$30,000	$30,000	$30,000
Average Annual Cost	**$8,229,000**	**$9,418,000**	**$10,150,000**	**$12,249,000**

- Construction and land costs are rounded to the nearest $100,000. Annualized costs are rounded to the nearest $1,000.

4.5.3.3 Cost Effectiveness Analysis

A CE analysis was conducted for the Tamiami Trail final array of alternative plans. The analyses compared the alternative plans' average annual costs against the appropriate AAHU estimates.

A summary of the average annual lift calculations and average annual costs results from the CE/ICA analysis is provided in ***Table 4-10***. The following figure and table show that Alternatives 2.2.2a, 2.2.2b, 3.2.2a and 3.2.2b are all cost effective alternatives. Alternative 3.2.2b provides the greatest habitat lift of all the alternatives, but Alternative 3.2.2a has the lowest average cost per unit of output.

TABLE 4-10: RESULTS OF COST EFFECTIVENESS ANALYSIS

Alternatives	Average Annual Cost	Output	Average Cost Per Output	Cost Effective?
Without Plan	$0	0	N/A	
2.2.2a	$8,229,000	8,559	$961	YES
2.2..2b	$9,418,000	9,154	$1,029	YES
3.2.2a	$10,150,000	13,109	$774	YES
3.2.2b	$12,249,000	13,705	$894	YES

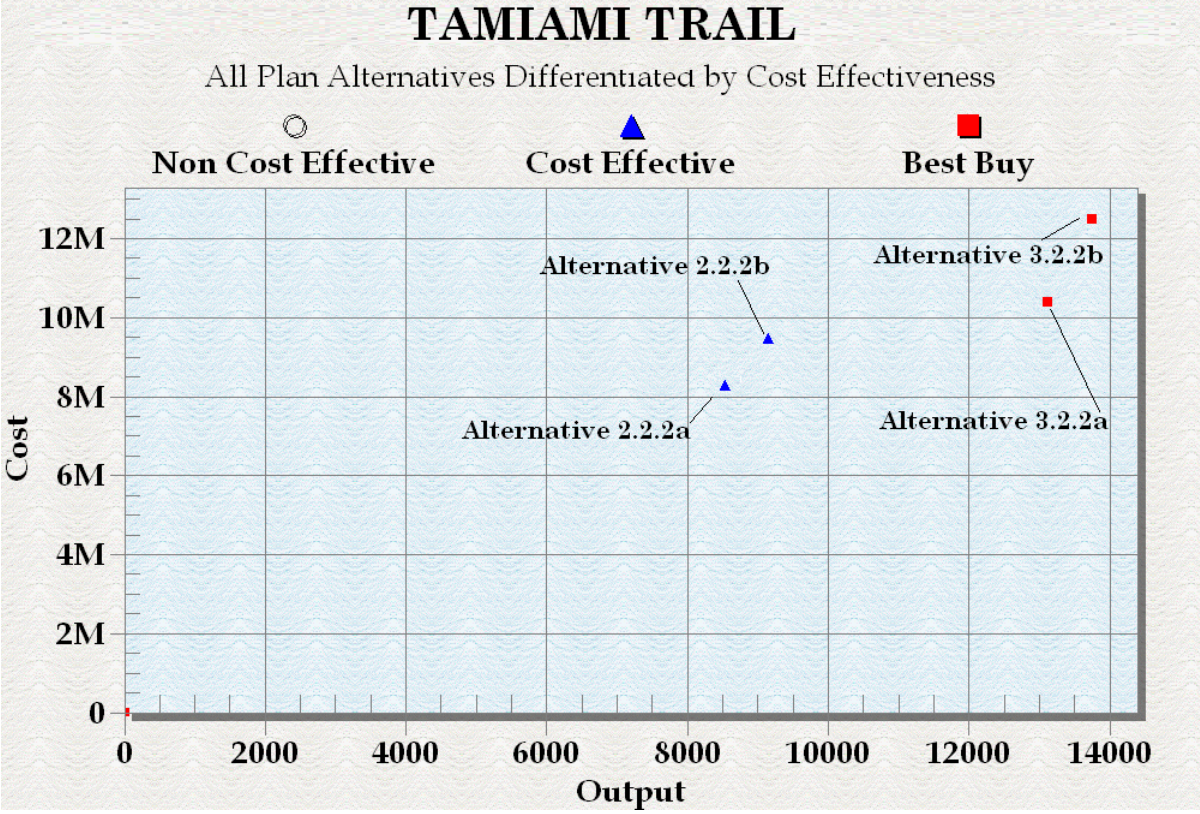

FIGURE 4-13: FINAL ARRAY OF ALTERNATIVES COST EFFECTIVE ANALYSIS RESULTS

4.5.3.4 Incremental Cost Analysis

After the cost effective plans are identified, the plans are arrayed by increasing outputs to clearly demonstrate changes in costs (i.e., increments of cost) and in outputs (i.e., increments of output). For comparison purposes, the average annual cost (AAC) per average annual habitat unit (AAHU) are then examined to determine the plan with the lowest AAC/AAHU. This plan is then considered the first "best buy" plan, or the plan that is the most efficient at producing a given level of output. After this first plan is identified, all larger cost effective plans are compared to this plan in terms of increases in (increments of) cost and increases in (increments of) output. The alternative plan with the next lowest incremental cost per unit of output (for all cost effective plans larger than the first "best buy" plan) is then considered the second best buy plan. ***Table 4-11*** presents the results of the ICA of the different alternative plans for the Tamiami Trail project. The results of the analysis show that there are two best buy plans (Alternatives 3.2.2a and 3.2.2b).

TABLE 4-11: RESULTS OF INCREMENTAL COST ANALYSIS–COST EFFECTIVE AND BEST BUY PLANS ARRAYED BY INCREASING OUTPUT

	Average Annual Cost	Output (Habitat Units)	Average Cost Per Output	Incremental Average Annual Cost	Incremental Output	Incremental Cost Per Output	Best Buy?
Without Plan	$0	0	N/A	N/A	N/A	N/A	
3.2.2a	$10,150,000	13,109	$774	$10,506,000	13,109	$774	Best Buy
3.2.2b	$12,249,000	13,705	$894	$2,099,000	596	$3,522	Best Buy

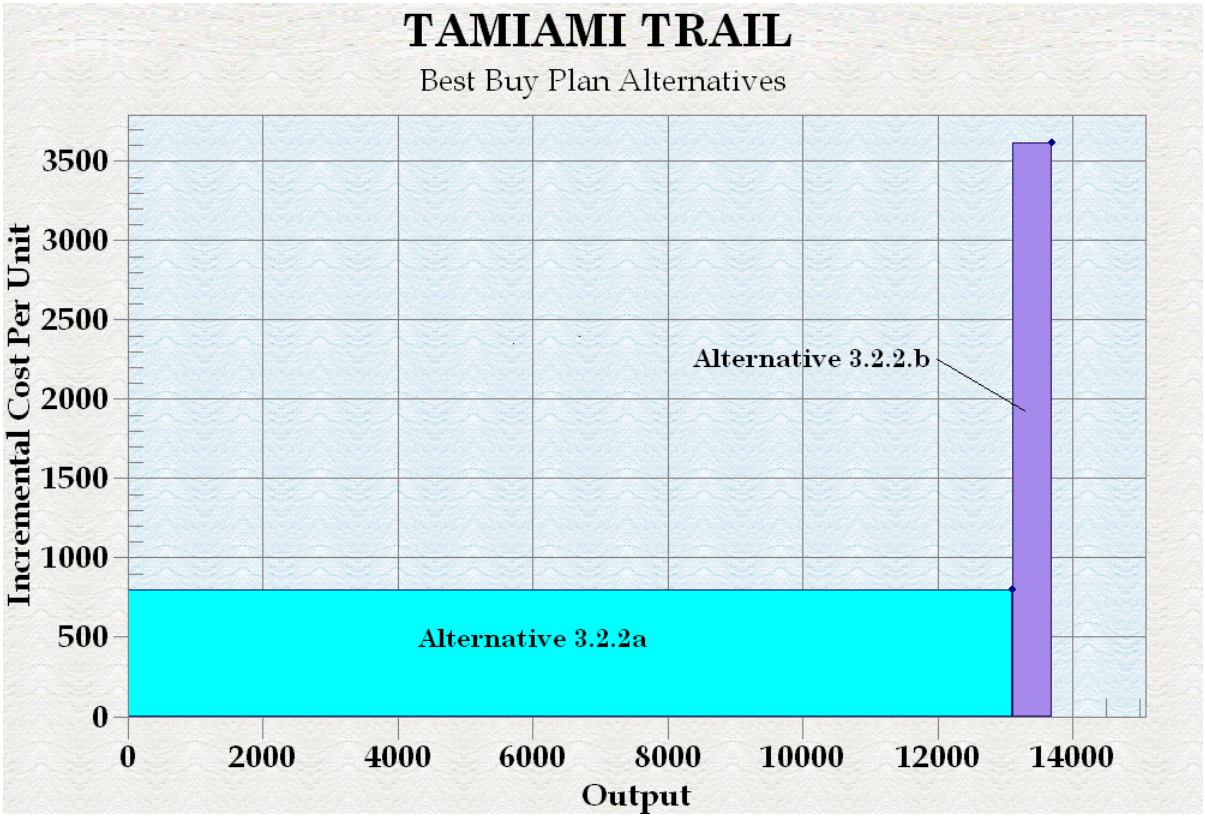

FIGURE 4-14: BEST BUY PLANS-TAMIAMI TRAIL CE/ICA RUN ON COMBINED AVERAGE ANNUAL HABITAT UNIT

4.5.3.5 Sensitivity Analysis

The preceding plan evaluation CE/ICA was conducted utilizing costs at a 90 percent confidence level. As previously described this implies that there is a 90 percent likelihood that the cost of construction would come in at this point or less. This high confidence level was selected to capture the risk associated with the costs of the project, and reduce the risk of underestimating the fully funded

project cost. This high confidence level warranted an additional analysis to ascertain that the results of the evaluation were not being skewed by incorporating this risk. This additional sensitivity analysis was conducted utilizing 50 and 80 percent confidence levels to examine the potential impact that utilizing less risk adverse costs would have on plan selection.

As can be seen in ***Table 4-12,*** the results of the CE/ICA do not change when lower cost confidence levels are used. Obviously the total economic investment is decreased for both of the lower confidence levels, due to the lower TCC, but this lower cost does not change the outcome of the analysis. The confidence level changes affect each alternative proportionately leading to the same alternatives being identified as the most efficient in production of HUs (best buys).

TABLE 4-12: SENSITIVITY OF CE/ICA TO DIFFERENT COST CONFIDENCE LEVELS

Alt.	Cost Confidence Level	Real Estate Cost	TCC	EDC	S&A	Construction, EDC and S&A Total	IDC Real Estate	IDC Construction	Total Economic Investment	Average Annual Cost (AAC)	Habitat Units (HU)	AAC/HU	Cost Effective/Best Buy?
2.2.2a	50%	$5,900,000	$122,000,000	$2,440,000	$10,370,000	$135,000,000	$ 670,000	$ 6,000,000	$147,570,000	$ 7,930,000	8,559	$927	Cost Effective
2.2.2b	50%	$5,900,000	$ 141,000,000	$2,800,000	$12,000,000	$156,000,000	$ 670,000	$ 6,930,000	$169,500,000	$ 9,110,000	9,154	$995	Cost Effective
3.2.2a	50%	$5,900,000	$ 150,000,000	$3,000,000	$12,750,000	$166,000,000	$ 670,000	$ 9,290,000	$181,860,000	$ 9,770,000	13,109	$745	Cost Effective/Best Buy
3.2.2b	50%	$5,900,000	$ 183,000,000	$3,700,000	$15,600,000	$202,000,000	$ 670,000	$11,330,000	$219,900,000	$ 11,810,000	13,705	$862	Cost Effective/Best Buy
2.2.2a	80%	$5,900,000	$124,000,000	$2,480,000	$10,540,000	$137,000,000	$ 670,000	$ 6,090,000	$149,660,000	$ 8,040,000	8,559	$939	Cost Effective
2.2.2b	80%	$5,900,000	$ 144,000,000	$2,900,000	$12,200,000	$159,000,000	$ 670,000	$ 7,080,000	$172,650,000	$ 9,280,000	9,154	$1,014	Cost Effective
3.2.2a	80%	$5,900,000	$ 153,000,000	$3,060,000	$13,005,000	$169,000,000	$ 670,000	$ 9,480,000	$185,050,000	$ 9,940,000	13,109	$758	Cost Effective/Best Buy
3.2.2b	80%	$5,900,000	$ 186,000,000	$3,700,000	$15,800,000	$206,000,000	$ 670,000	$11,520,000	$224,090,000	$ 12,040,000	13,705	$879	Cost Effective/Best Buy

4.6 Additional Factors

4.6.1 Compatibility with Future Projects

As discussed during the screening of the 27 initial alternatives, L-29 Canal stages currently only go above 7.5 feet approximately 12 percent of the time based on analyzing the period of record from 1983 through 2007. This is achieved by operating the water control structure S-333 at the southeast corner of WCA-3A to minimize events with stages greater than 7.5 feet, for protection of the Tamiami Trail roadway embankment and flood protection for south Dade County based on the trigger gage G-3273. Instances where stages exceed 7.5 feet in the L-29 Canal are typically a result of direct rainfall on the area.

The pre-drainage system (as represented by NSM version 4.6.2) would produce a different hydroperiod for NESRS based on a different timing, volume, and distribution of flows much higher than the existing condition within the area. ***Figure 4-15*** compares the frequency of stage occurrences from three different model runs based on the same hydrologic (rainfall) conditions (1965 through 2000, a total of 13,149 modeled days) but different operational criteria and landscape. These model runs represent the NSM, existing conditions (referred to as ALT7R5, based on the IOP for the protection of the CSSS), and the future CERP (which assumes that all proposed CERP restoration features are in-place). The NSM and CERP analysis both use unconstrained flow in modeling the volume of water conveyed into NESRS. This figure shows the inherent problems of the current operations of the system in regards to NESRS being held too low due to constraints on the system and not being able to see the natural fluctuations of stages needed to support the ecology.

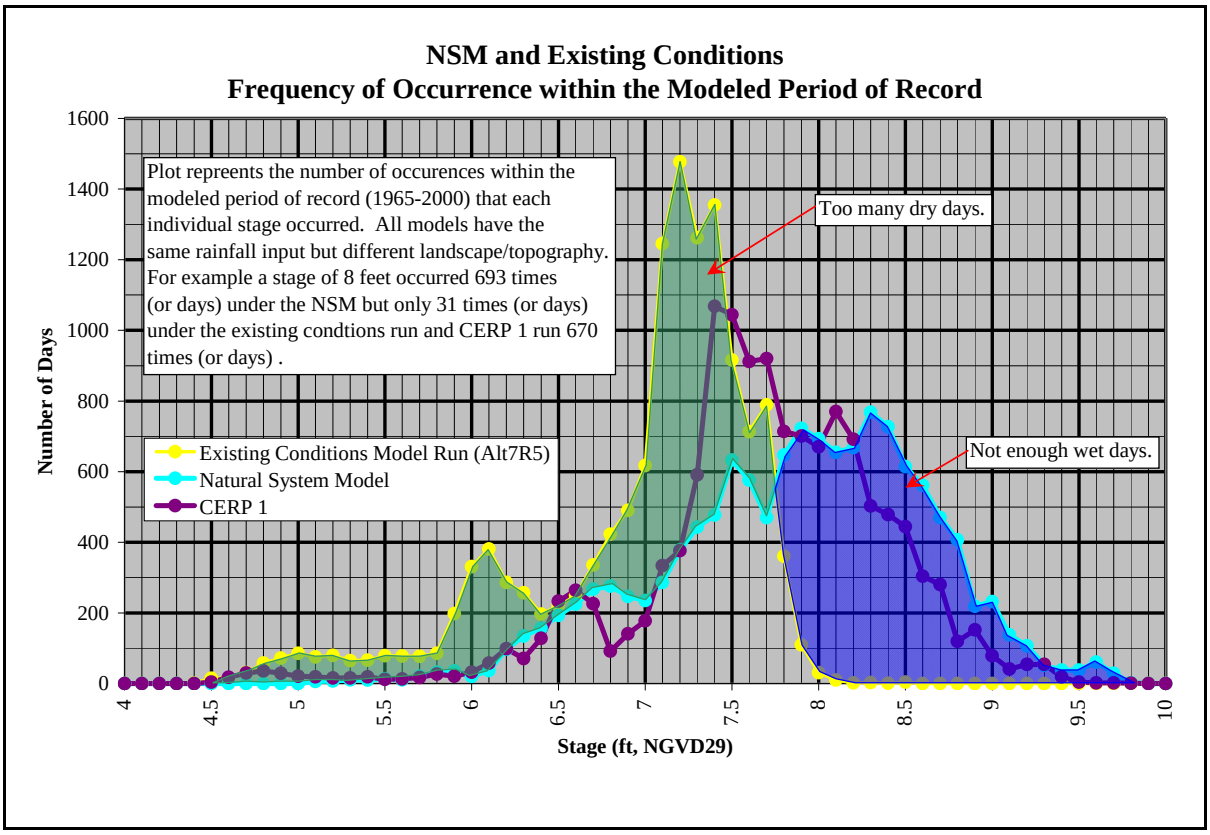

FIGURE 4-15: FREQUENCY OF STAGE OCCURRENCE FOR DIFFERENT MODEL SCENARIOS

Existing studies have determined that water levels must be raised higher than the stages considered in the final suite of alternatives. Section 601(b)(2)(C) of WRDA 2000 authorized raising and bridging of Tamiami Trail as an initial project of the CERP. It is therefore necessary to ensure that Tamiami Trail modifications projects are compatible with CERP. However, bridges constructed under this project would not have to be replaced or "un-done" by future projects. Any bridge constructed would be high enough to accommodate any anticipated stage in the L-29 Canal produced by CERP or other projects in the future. Modifications to the Tamiami Trail roadway embankment however would have to be made to incorporate higher stages and removal of sections of the roadway to increase the hydrologic connectivity to NESRS to produce a more natural sheet flow pattern between WCA-3B and ENP.

The degree of compatibility of the remaining roadway with future restoration projects is not as simple. On one hand, any length of road, at any height, represents a barrier to sheet flow and ecological connectivity. Future restoration projects may involve additional openings and/or additional water stage increases and associated road mitigation (road reinforcing). Differences among the LRR

alternatives of compatibility with these unspecified future restoration project depends on what features would in these future projects.

If an additional conveyance opening (bridge) was recommended for a future restoration project, then some of the asphalt and fill placed as part of the MWD Tamiami Trail project alternatives would have to be removed. For Alternatives 2.2.2a and 2.2.2b (stage 8.0), the amount of "new" material that would be removed would be less than for Alternatives 3.2.2a and 3.2.2b (stage 8.5). The lower road for the 8.0 stage alternatives would be more compatible than the higher road for the 8.5 stage alternatives.

If the future restoration project recommended in the L-29 Canal an additional increase in the stage (road height), then the asphalt and fill placed as part of the LRR alternatives would be usable to the new plan. The new project would have to provide less new material if Alternatives 3.2.2a or 3.2.2b (stage 8.5) were implemented than if Alternatives 2.2.2a or 2.2.2b (stage 8.0) were implemented. The 8.5 stage alternatives, with a higher road surface, would be more compatible than the 8.0 stage alternatives, with the lower road surface.

4.6.2 Real Estate

All four alternatives would require real estate transactions and agreements among the following public agencies: (1) FDOT and ENP for any new bridge, which would be located on land currently owned by ENP; (2) SFWMD and ENP for access and maintaining flows under any bridges that may be constructed; (3) USACE and ENP for temporary construction activities on ENP land; and (4) USACE and FDOT for construction of the road and/or bridge.

All four alternatives have road work included which would require temporary work area easements from each private landowner within the project footprint to construct access from the reinforced road down to the existing driveway or parking lot.

All four alternatives have a proposed bridge. Additional water would flow to an elevation of approximately 8.5 feet and may impact privately owned properties south of Tamiami Trail. At a minimum, perpetual flowage easements would be required on each parcel prior to implementing the operation of the project. If it is determined during the appraisal process that the value of the easement estate approaches fee value, it may be in the best interest of the government to acquire fee for the operation and maintenance of the project. The impacts to each parcel are discussed in Appendix F of this report.

In addition to the real estate requirements discussed above, Alternatives 2.2.2a and 3.2.2a for bridge construction require perpetual road and channel easements from FP&L as they own a parcel of land that runs north-south across the project.

Alternatives 2.2.2b and 3.2.2b bridge construction would cross the access road to the Lincoln Financial radio tower site. An alternate access to this facility would be required. If an alternate access route is not possible, the real estate interest required would be fee.

Since the width of Tamiami Trail would not be increased under any of the final four alternatives, the footprint of the reinforced road would not encroach on any privately owned properties.

4.6.3 Timing of Project Implementation

Construction of the eastern bridge of Alternatives 2.2.2a or 3.2.2a can start earlier than the western bridge of the other two final alternatives. The USACE began detailed design of the selected plan from the 2005 RGRR soon after its ROD was signed in January 2006, and was nearly complete with the design when this LRR was initiated. The eastern bridge of Alternatives 2.2.2a and 3.2.2a is identical to the eastern bridge of the 2005 RGRR plan and these alternatives can use the nearly completed design developed for the 2005 RGRR plan. The western bridge of Alternatives 2.2.2b and 3.2.2b is different from the western bridge of the 2005 RGRR plan in that it is only one mile long rather than two miles long. A geotechnical survey performed during the design phase of the 2005 RGRR plan discovered soil conditions of the area of the western bridge that require a redesign of the foundations for the western bridge. The differences in length and soil conditions prevent reusing much of the engineering and design initially developed for the 2005 RGRR plan, and additional time would be required for redesign. This would result in a later start date for construction.

Mitigation of the road to accommodate a stage of either 8.0 or 8.5 feet is different from raising and widening the road for the 2005 plan, which was to 9.7 feet stage, and would require additional engineering prior to construction. However, it is expected that road design, and the subsequent construction, could be completed within the time period needed for bridge construction.

The timing of construction influences the cost of construction-the longer the time to construction, the greater the cost growth due to the effects of risk factors and escalation. Construction market conditions continue to be volatile in south Florida and these conditions have been documented by FDOT, SFWMD and USACE. These volatile conditions would likely continue for the foreseeable future, since they are influenced by both world and local market conditions. Additionally, several large upcoming construction contracts associated with the Acceler8/CERP program would likely add to the competition for the labor, equipment and materials needed to construct these projects which would result in higher construction costs.

4.6.4 Evaluation of the Planning Objectives

Table 4-13 illustrates how each of the final four alternatives addresses each of the planning objectives. Alternative 1.0, the No Action Alternative, does not address any of the planning objectives.

TABLE 4-13: PLANNING OBJECTIVES FOR FINAL ALTERNATIVES

Objectives	1.1 No Action	2.2.2a Stage 8.0, Reinforce Road, 1-mile Bridge East	2.2.2b Stage 8.0, Reinforce Road, 1-mile Bridge West	3.2.2a Stage 8.5, Reinforce Road, 1-mile Bridge East	3.2.2b Stage 8.5, Reinforce Road, 1-mile Bridge West
Provide additional water into Shark River Slough	Average 177,000 acre feet per year. No change	Increase in average annual flow to 274,000, 55% increase over No Action;	Same as 2.2.2a	340,000 acre feet per year. 93% increase over No Action; 26% increase over Alt 2.2.2a	Same as 3.2.2a
Restore processes that produce and maintain ridge and slough communities	No connection to sloughs. High velocity near culverts is damaging.	Moderate restoration. Bridge alts pass more water into existing sloughs. Velocities at culverts and bridge are not damaging.	Same as 2.2.2a	Same as 2.2.2a	Same as 2.2.2a
Restore slough vegetation	86 days with water depth >2 feet. No change	Substantially more days (1,428) with required conditions (water depth >2 feet) 1,560% inc over No Action	Same as 2.2.2a	Substantially more days (2,578) with required conditions (water depth >2 feet). 2,898% inc over No Action; 81% inc over 2.2.2a	Same as 3.2.2a
Reduce highway-caused mortality	No reductions. No change	Mortality reduced by 261 per year (9 percent)	Same as 2.2.2a	Same as 2.2.2a	Same as 2.2.2a
Increase ecological connectivity between Shark River Slough and the WCAs north of the roadway	No change	No direct connection. Indirect increase due to the 1-mile connection of ENP to L-29 Canal; canal connects to S-333 and WCA-3A.	Same as 2.2.2a	Same as 2.2.2a	Same as 2.2.2a
Increase peak flows to 1,400 cfs and target 4,000 cfs	Average peak flow 1,250 cfs. No change.	Peak flow 1,577 cfs. 26% increase over No Action		Peak flow 1,848 cfs. 48% inc over No Action; 17% inc over 2.2.2a	Same as 3.2.2a

4.6.5 Evaluation of the Planning Constraints

Some of the initial 27 alternatives did not satisfy one or more of the planning constraints and thus were eliminated from the final array of alternatives. All of the final four action alternatives satisfy all of the constraints identified by the team. The list of constraints is repeated here for ease of reference.

1. Maintain traffic along Tamiami Trail
2. Avoid causing additional damage to Tamiami Trail
3. Minimize adverse socioeconomic impacts on local businesses, residents
4. Avoid degradation of water quality in ENP or any of the contributing water bodies
5. Not adversely affect listed species
6. Start construction by 2010

4.6.6 Evaluation of Planning Criteria and Identification of the NER Plan

USACE policy (Engineering Regulation [ER] 1102-2-100) requires the use of four screening criteria in the evaluation of plans. The identification of the National Ecosystem Restoration plan incorporates the results of the CE/ICA analysis with the four planning criteria to make an informed plan selection decision. The planning criteria are acceptability, completeness, effectiveness and efficiency. Results are described below and summarized in ***Table 4-14***.

TABLE 4-14: SCREENING CRITERIA FOR EVALUATION OF PLANS

Criteria	1.0 No Action	2.2.2a Stage to 8.0, Reinforce Road, 1-mile Bridge East	2.2.2b Stage to 8.0, Reinforce Road, 1-mile Bridge West	3.2.2a Stage to 8.5, Reinforce Road, 1-mile Bridge East	3.2.2b Stage to 8.5, Reinforce Road, 1-mile Bridge West
Acceptability	No	Yes	Yes	Yes	Yes
Completeness	N/A	Complete	Complete	Complete	Complete
Effectiveness	No benefits; does not address planning objectives	Fewest benefits of the final four action Alts	Second fewest benefits; slightly more than Alt 2.2.2a	Provides the second most benefits, very similar to Alt 3.2.2b	Provides the most benefits
Efficiency (Avg annual cost/ avg annual habitat unit)	N/A	$961/aahu Second highest unit cost of the final Alts	$1,029/aahu Highest unit cost of the bridge Alts	$741/aahu Lowest cost per unit of benefit	$894/aahu Second lowest unit cost; intermediate between 3.2.2a and the 8.0 stage alts

Acceptability is the workability and viability of the alternative plan with respect to acceptance by state and local entities and the public as well as compatibility with existing laws, regulations and public policies. One aspect of acceptability is whether the alternative is feasible or doable with regard to technical, environmental, economic, social or similar reasons.

Completeness is the extent to which an alternative plan includes and accounts for all necessary investments or other actions to ensure the realization of the planned effects. All of the final four alternatives contain all of the features needed to achieve the predicted benefits.

Effectiveness is the extent to which an alternative plan contributes to the attainment of the planning objectives. The most effective alternatives make significant contributions to all of the planning objectives. Less effective alternatives make smaller contributions to one or more of the alternatives.

Effectiveness is a matter of degree rather than all or nothing. Among the final four alternatives, Alternatives 3.2.2a and 3.2.2b contribute more to the planning objectives. They provide the most AAHU lift, the most flow volume, the best conditions for restoring slough vegetation, and the greatest reduction in wildlife mortality (***Table 4-13*** and ***Table 4-14).*** Alternatives 2.2.2a and 2.2.2b perform similarly to each other and provide substantial benefits, but are less effective in contributing to the objectives than Alternatives 3.2.2a and 3.2.2b.

Efficiency is the extent to which an alternative plan is the most cost-effective means of alleviating problems and realizing opportunities, consistent with protecting the nation's environment. It is a measure of allocation of resources. CE is one common measure of efficiency. Both monetary and non-monetary costs are considered. All four alternatives are cost effective in that if additional money were spent for a larger plan, more benefits would be achieved. The 8.5 foot stage plans (Alternatives 3.2.2a and 3.2.2b) have lower costs per unit of benefit gained than the 8.0 foot stage plans. Alternative 3.2.2a has the lowest cost per unit of benefit among the final alternatives.

The results of the CE/ICA analysis identified two alternatives as best buy plans; Alternatives 3.2.2a and 3.2.2b. The national ecosystem restoration (NER) plan is typically identified from the final set of best buy solutions by evaluating whether successive investments are worth the additional expenditure. Comparing alternatives 3.2.2a and 3.3.2b from Table 4-11, it is evident that 3.2.2b provides 5% more output (habitat units) than does alternative 3.2.2a, while the annual cost is 20% greater. The 596 additional units of output come at an incremental cost that is almost 5 times greater than the cost per unit of output for Alternative 3.2.2a. Given the steep increase in cost and relatively small increase in output, it was determined that Alternative 3.2.2a was the plan that reasonable maximized ecosystem restoration benefits compared to costs, and therefore was identified as the NER plan. This plan is consistent with federal objectives and is a complete and effective alternative.

4.6.7 Evaluation of Managers' Report Directives

The conference report for the WRDA 2007 contained language to the Chief of Engineers regarding the MDW project and the Tamiami Trail component. The directives in that report are not considered law, but are considered strong guidance to the project team. Section 1 of the LRR discusses some of these directives. ***Table 4-15*** presents the directives and the status of how well the final alternatives satisfy the directives.

TABLE 4-15: WRDA 2007 CONFERENCE REPORT MANAGERS' DIRECTIVES

Directive	Status
Take steps upon completion of 8.5 SMA to increase flows to Park of at least 1,400 cfs without significantly increasing risk of roadbed failure	Most initial alternatives can achieve 1,400 cfs peak flow. All of the final alternatives achieve 1,400
Reexamine prior reports and evaluate practicable alternatives	Complete
Recommendations consistent with directive in ENP Protection and Expansion Act; "improve water deliveries to the park and shall, to the extent practicable, take steps to restore natural hydrologic conditions within the Park." The managers direct that the flows to the Park have a minimum target of 4,000 cfs so as to address the restoration envisioned in the ENP Protection and Expansion Act.	4,000 cfs target was assessed. 4,000 cfs events require large storms which occur rarely. Only three alternatives would achieve 4,000 cfs. These were screened due to very high cost.
Take into account future modifications to Tamiami Trail may be performed under CERP; modifications that are not compatible or duplicative should be avoided.	Compatibility and duplication are considered
Submit for public review and comment	Review scheduled to begin early April 2008
Submit to Congressional committees by July 1, 2008	In-progress. On-schedule to meet this deadline.
Cost sharing arrangements are prospective only	Complete
Do not support arrangement where DOI is credited for land acquisition toward the costs of modifying water delivery to the Park. These costs are separate responsibilities within the missions of Army and Interior. Costs of one should not be used to offset the costs of the other.	Land acquisition costs are reported separately in the Real Estate appendix. Credit is not recommended.
Initiate evaluation of Tamiami Trail component of CERP as soon as practicable, including an evaluation of modifying Tamiami Trail from Krome Avenue to the boundary of Big Cypress National Preserve	Not started. Plan to initiate study once this LRR is complete.

4.7 Recommended Plan

The Recommended Plan is Alternative 3.2.2a, raise L-29 Canal stage constraint to 8.5 feet and a one-mile eastern opening and bridge. This study initially analyzed 27 alternatives, screened the total to four alternatives, and then after further analysis identified one alternative as the Recommended Plan–the best alternative among the final four alternatives. Alternative 3.2.2a would raise the constraint in the L-29 Canal one-foot to 8.5 feet NGVD. The Recommended Plan includes a one-mile bridge in the eastern section of the 10.7 mile length of road. The Recommended Plan also includes roadway reinforcement of the remainder of Tamiami Trail. Additional details of this alternative are in Section 6 of this report.

Alternative 3.2.2a represents a balance between alternatives that produce a very large quantity of ecosystem benefits but are very costly and alternatives that are less expensive but provide few ecosystem benefits. Alternative 3.2.2a meets both the requirements to exceed minimum flow and benefits to NESRS and to stay below the cost of the 2005 RGRR plan.

Alternative 3.2.2a makes more progress toward achieving objectives–increased water delivery, ridge and slough processes and connectivity, slough vegetation, and wildlife mortality–than all but one of the final four alternatives. CE/ICA shows that Alternative 3.2.2a is cost effective and has the lowest cost per unit of benefit. The average cost per HU and the incremental cost of the next larger plan, Alternative 3.2.2b, are higher than for Alternative 3.2.2a.

Construction on Alternative 3.2.2a can be initiated much earlier than two of the other final alternatives. The bridge of Alternative 3.2.2a is identical to the eastern bridge of the 2005 RGRR Selected Plan. The bridges of Alternatives 2.2.2b and 3.2.2b are less similar to the 2005 plan and would require additional time for additional design. Construction on the eastern bridge for Alternative 3.2.2a could start as early as October 2008 whereas the western bridge of Alternative 2.2.2b or 3.2.2b would not start until approximately one year later. Because of further design needed, roadway reinforcing for any of the final four alternatives could not start as quickly as the eastern bridge. Since completion of a bridge is expected to take longer than roadway reinforcing, an earlier start of a bridge represents the earlier completion of all construction and earlier achievement of ecosystem benefits. The recent history of rapid cost growth (Section 2 and Appendix C) also suggests that waiting to start construction would result in substantial escalation of cost.

Alternative 3.2.2a includes a one-mile bridge that would be able to handle any higher stage in the L-29 Canal that might be recommended by future projects. This bridge would not have to be retrofitted and would continue to provide unobstructed flow. The other three final alternatives would also attain this level

of compatibility. Some of the alternatives that were screened from the final analysis included raising the stage in the L-29 Canal but did not include bridges. As a result, if future restoration projects recommend higher stages in the L-29 Canal, all of the work completed under these alternatives would have to be retrofitted or replaced. No features would be "permanent" for these potential future actions.

Operations. The analyses performed during this study effectively compare alternatives, but are not able to fully analyze operational plans for the structures that deliver water to this project. The benefits described in the LRR/EA are potential benefits associated with the evaluation of the LRR alternatives based on a single constraint of 8.5 feet in the L-29 Canal. It must be recognized that additional constraints will be required by FDOT immediately before and during some large rainfall events in order to ensure the stability and safety of the highway. Therefore, when these FDOT constraints are applied to the recommended plan, there will be some change of benefits from those identified in this document. During the Combined and Structural and Operational Plan (CSOP) alternative planning process, the effects of these constraints on benefits will be thoroughly evaluated. In addition, there is an expectation that field monitoring, based on a reconfiguration of existing monitoring activities, will continue following implementation of the LRR features in conjunction with the CSOP operating plan. Such monitoring will allow for adaptive management to potentially mitigate any loss of benefits from those identified in this document.

4.8 Environmentally Preferred Alternative

The NPS is required to identify the environmentally preferred alternative in its NEPA documents for public review and comment. The NPS, in accordance with the DOI policies contained in the Department Manual (516 DM 4.10) and the Council on Environmental Quality's Forty Questions, defines the environmentally preferred alternative (or alternatives) as the alternative that best promotes the national environmental policy expressed in NEPA (Section 101(b)) which considers: (1) fulfilling the responsibilities of each generation as trustee of the environment for succeeding generations; (2) assuring for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings; (3) attaining the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences; (4) preserving important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity, and variety of individual choice; (5) achieving a balance between population and resource use which would permit high standards of living and a wide sharing of life's amenities; and (6) enhancing the quality of renewable resources and approach the maximum attainable recycling of depletable resources."

The Council on Environmental Quality's Forty Questions (Q6a), further clarifies the identification of the environmentally preferred alternative, stating "ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves and enhances historic, cultural, and natural resources."

Based on the analysis prepared for the 2005 RGRR/SEIS and input from other agencies and the public, the ROD for the RGRR/SEIS identified the environmentally preferred alternative for the Tamiami Trail Modifications component of the MWD Project as the 10.7 mile bridge (Alternative 17 in the RGRR/SEIS). This alternative was not recommended for implementation in the RGRR/SEIS because of its extremely high cost and significant adverse cultural and socio-economic impacts (ROD page 2). For this LRR, the 10.7 mile bridge alternative (Alternative 4.2.4) is again the environmentally preferred alternative. As before, this alternative was not recommended for implementation in the LRR because of its extremely high cost.

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